Pre-Disaster Hazard Mitigation Plan

Mount Rogers Region, Virginia

October 2004

Directed by the
Mount Rogers Hazard Mitigation Advisory Team

Complied by the Mount Rogers Planning District Commission

Ronald R. Catron, Chairman

Funding through the **Virginia Department of Emergency Management**
From the **Federal Emergency Management Agency**

Front Cover photo identification, clockwise from upper left:

- Clip Art image of snow scene.
- Flooding on Middle Fork Holston River in Marion, as seen from town recreation center.
- Internet image of firefighter in wooded setting.
- Flooding on Chestnut Creek in industrial district of City of Galax.
- Flooding on Middle Fork Holston River going over Ice Plant Dam in Marion.

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Section One

Executive Summary: Pre-Disaster Hazard Mitigation

Organization of Document

The Pre-Disaster Hazard Mitigation Plan is meant to describe natural hazards and their impacts to people and property; recommend mitigations to reduce or eliminate those hazards; and outline the strategy for maintaining and updating the Plan.

The Federal Emergency Management Agency defines hazard mitigation as "sustained actions taken to reduce or eliminate long-term risk from hazards and their effects."

This Plan addresses natural hazards of importance to the Mount Rogers Planning District region of southwest Virginia. This is a rural, mountainous region covering 2,777 square miles that stands within both the Ridge & Valley and Blue Ridge geologic provinces. In the future the expectation is that this plan also will be required by law to address human-caused hazards, including terrorism.

This document is arranged by sections, with **Section 1** consisting of the Executive Summary and **Section 2** as an introduction to this project, its legal foundations, and the planning process used to develop the Plan.

Section 3 discusses hazards and vulnerability assessments for 11 natural hazards that affect the Mount Rogers region. This section includes further information on the region's physical characteristics and its weather patterns, political boundaries, population, and economy. The vulnerability assessments discuss hazards one-by-one, although in reality natural hazards often overlap each other rather than occur as singular events. Some identified hazards cannot be assessed in detail due to lack of basic data.

Recommended mitigations to be used to address the identified hazards is addressed in **Section 4**, which describes a regional hazard mitigation strategy (goals and objectives), followed by recommended mitigations for each of the local jurisdictions. The implementation strategy for the recommended mitigations is described in table format. Closing comments concerns lessons learned from undertaking this study.

Section 5 provides an outline for Plan implementation and maintenance, which is also a required element of the federal Disaster Mitigation Act of 2000.

Local resolutions of adoption approved by the participating jurisdictions in the Mount Rogers region can be found in **Section 6**.

The extensive **Appendices Section** includes an accounting on those who participated in the development of the Plan; further data details on given hazards; maps on dams, earthquake locales, floodplains, karst, wildfire risk areas, and a high-wind region for southwest Virginia; methods used to make certain calculations; and information references, listed by subject area.

FEMA Crosswalk

Local Mitigation Plan Review and Approval Status

Jurisdiction: Mount Rogers Planning District, Virginia	**Title of Plan:** Mount Rogers Pre-Disaster Hazard Mitigation Plan – Draft HIRA Section	**Date of Plan:** November 2004
Local Point of Contact: James Dillon	**Address:** 1021 Terrace Drive, Marion, VA 24354	
Title: GPS/GIS Specialist		
Agency: Mount Rogers Planning District Commission		
Phone Number: 276-783-5103	**E-Mail:** jdillon@mrpdc.org	

State Reviewer:	**Title:**	**Date:**

FEMA Requirement:		
Contractor Reviewer:	**Title:**	**Date:**
Contractor QA/QC: Stuart Wallace, AICP	**Title:**	**Date:**
FEMA Reviewer:	**Title:**	**Date:**
FEMA QA/QC:	**Title:**	**Date:**
Date Received in FEMA Region III	**N/A**	
Plan Not Approved		
Plan Approved		
Date Approved		

Jurisdiction:	NFIP Status*			
	Y	**N**	**N/A**	**CRS Class**
1. **Bland County**	X			
2. **Carroll County**	X			
3. Town of Hillsville		X		
4. **Grayson County**	X			
5. Town of Fries		X		
6. Town of Independence	X			
7. Town of Troutdale			X	
8. **Smyth County**	X			
9. Town of Chilhowie	X			
10. Town of Marion	X			
11. Town of Saltville	X			
12. **Washington County**	X			
13. Town of Abingdon	X			
14. Town of Damascus	X			
15. Town of Glade Spring	X			
16. **Wythe County**	X			
17. Town of Rural Retreat			X	
18. Town of Wytheville	X			
19. City of Bristol	X			
20. City of Galax		X		

*** Notes: Y = Participating N = Not Participating N/A = Not Mapped**

RISK ASSESSMENT: *§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Identifying Hazards

Requirement §201.6(c)(2)(i): *[The risk assessment **shall** include a] description of the type … of all natural hazards that can affect the jurisdiction.*

Element	Location in the Plan (section or annex and page #)
A. Does the plan include **a description** of the types of **all natural hazards** that affect the jurisdiction?	Section 3\ 26,83,85

Profiling Hazards

Requirement §201.6(c)(2)(i): *[The risk assessment **shall** include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.*

Element	Location in the Plan (section or annex and page #)
A. Does the risk assessment identify the **location** (i.e., geographic area affected) of each natural hazard addressed in the plan?	Section 3\ 32,33,35,39,44,45, 63,64,67,71,75,81,85
B. Does the risk assessment identify the **extent** (i.e., magnitude or severity) of each hazard addressed in the plan?	Section 3\ 36,37,46-49,56,57, 63-65,67,68,71,75,76,81
C. Does the plan provide information on **previous occurrences** of each hazard addressed in the plan?	Section 3\ 28-30,35,38,39,43-45,56,57,60,63-65,67,68,71-72,75,76,80,81
D. Does the plan include the **probability of future events** (i.e., chance of occurrence) for each hazard addressed in the plan?	Section 3\ 31,36,41,52,62,65, 68,73,78,82

Additional Suggestions for Profiling Hazards:

Assessing Vulnerability: Overview

Requirement §201.6(c)(2)(ii): *The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.*

Element	Location in the Plan (section or annex and page #)
A. Does the plan include an **overall summary** description of the jurisdiction's **vulnerability** to each hazard?	
B. Does the plan address the **impact** of each hazard on the jurisdiction?	

Assessing Vulnerability: Identifying Structures

Requirement §201.6(c)(2)(ii)(A): *The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area..*

Element	Location in the Plan (section or annex and page #)
A. Does the plan describe vulnerability in terms of the **types and numbers** of **existing** buildings, infrastructure, and critical facilities located in the identified hazard areas?	Section 3\ 54 Appendices 129-130
B. Does the plan describe vulnerability in terms of the **types and numbers** of **future** buildings, infrastructure, and critical facilities located in the identified hazard areas?	Appendices 174-177

Assessing Vulnerability: Estimating Potential Losses

Requirement §201.6(c)(2)(ii)(B): *The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.*

Element	Location in the Plan (section or annex and page #)
A. Does the plan estimate **potential dollar losses** to vulnerable structures?	Section 3\ 54 Appendices 129-130,140-143
B. Does the plan describe the **methodology** used to prepare the estimate?	Appendices 172,173

Assessing Vulnerability: Analyzing Development Trends

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Element	Location in the Plan (section or annex and page #)
A. Does the plan describe land uses and development trends?	Appendices 174-177

Multi-Jurisdictional Risk Assessment

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

Element	Location in the Plan (section or annex and page #)
A. Does the plan include a risk assessment for each participating jurisdiction as needed to reflect unique or varied risks?	Section 3\ 85

Matrix A: Profiling Hazards

Note: First, check which hazards are identified in requirement §201.6(c)(2)(i). Then, place a checkmark in either the N or S box for each applicable hazard. An "N" for any element of any identified hazard will result in a "Needs Improvement" score for this requirement. List the hazard and its related shortcoming in the comments section of the Plan Review Crosswalk.

Hazard Type	Hazards Identified Per Requirement §201.6(c)(2)(i)	A. Location		B. Extent		C. Previous Occurrences		D. Probability of Future Events	
	Yes	N	S	N	S	N	S	N	S
Avalanche	☐	☐	☐	☐	☐	☐	☐	☐	☐
Coastal Erosion	☐	☐	☐	☐	☐	☐	☐	☐	☐
Coastal Storm	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dam Failure	☐	☐	☐	☐	☐	☐	☐	☐	☐
Drought	☒	☐	☒	☐	☒	☐	☒	☐	☒
Earthquake	☒	☐	☒	☐	☒	☐	☒	☒	☐
Expansive Soils	☐	☐	☐	☐	☐	☐	☐	☐	☐
Extreme Heat	☐	☐	☐	☐	☐	☐	☐	☐	☐
Flood	☒	☐	☒	☐	☒	☐	☒	☐	☒
Hailstorm (see Tornado)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hurricane	☒	☐	☒	☐	☒	☐	☒	☒	☐
Land Subsidence	☒	☐	☒	☒	☐	☐	☒	☒	☐
Landslide	☒	☐	☒	☒	☐	☐	☒	☒	☐
Severe Winter Storm	☒	☒	☐	☒	☐	☐	☒	☒	☐
Tornado	☒	☒	☐	☒	☐	☐	☒	☒	☐
Tsunami	☐	☐	☐	☐	☐	☐	☐	☐	☐
Volcano	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wildfire	☒	☐	☒	☒	☐	☐	☒	☐	☒
Windstorm	☒	☐	☒	☒	☐	☐	☒	☐	☒
Other: Thunderstorms and Lightning	☒	☒	☐	☐	☒	☐	☒	☒	☐

Legend:
§201.6(c)(2)(i) Profiling Hazards
A. Does the risk assessment identify the location (i.e., geographic area affected) of each hazard addressed in the plan?
B. Does the risk assessment identify the extent (i.e., magnitude or severity) of each hazard addressed in the plan?
C. Does the plan provide information on previous occurrences of each natural hazard addressed in the plan?
D. Does the plan include the probability of future events (i.e., chance of occurrence) for each hazard addressed in the plan?

Matrix B: Assessing Vulnerability

*Note: First, check which hazards are identified in requirement §201.6(c)(2)(i). Then, place a checkmark in either the N or S box for each **applicable** hazard. An "N" for any element of any identified hazard will result in a "Needs Improvement" score for this requirement. List the hazard and its related shortcoming in the comments section of the Plan Review Crosswalk.*

Hazard Type	Hazards Identified Per Reqmt §201.6(c)(2)(i)	§201.6(c)(2)(ii) Assessing Vulnerability: Overview					§201.6(c)(2)(ii) Assessing Vulnerability: Identifying Structures				§201.6(c)(2)(ii) Assessing Vulnerability: Estimating Potential Losses			
		A. Overall Summary Descrip. of Vulnerability		B. Hazard Impact			A. Types and Number of Existing Structures in Hazard Area (Estimate)		B. Types and Number of Future Structures in Hazard Area (Estimate)		A. Loss Estimate		B. Method	
	Yes	**N**	**S**	**N**	**S**		**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Avalanche	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Coastal Erosion	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Coastal Storm	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Dam Failure	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Drought	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐
Earthquake	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☐	☒
Expansive Soils	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Extreme Heat	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Flood	☒	☐	☒	☐	☒		☒	☐	☒	☐	☐	☒	☐	☒
Hailstorm	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Hurricane (see tornado)	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Land Subsidence	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐
Landslide	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐
Severe Winter Storm	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐
Tornado	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐
Tsunami	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Volcano	☐	☐	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐
Wildfire	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☐	☒
Windstorm	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐
Other: Thunderstorms and lightning	☒	☐	☒	☐	☒		☒	☐	☒	☐	☒	☐	☒	☐

Legend:

§201.6(c)(2)(ii) Assessing Vulnerability: Overview

A. Does the plan include an overall summary description of the jurisdiction's vulnerability to each hazard?

B. Does the plan address the impact of each hazard on the jurisdiction?

§201.6(c)(2)(ii)(A) Assessing Vulnerability: Identifying Structures

A. Does the plan describe vulnerability in terms of the types and numbers of existing buildings, infrastructure, and critical facilities located in the identified hazard areas?

B. Does the plan describe vulnerability in terms of the types and numbers of future buildings, infrastructure, and critical facilities located in the identified hazard areas?

§201.6(c)(2)(ii)(B) Assessing Vulnerability: Estimating Potential Losses

A. Does the plan estimate potential dollar losses to vulnerable structures?

B. Does the plan describe the methodology used to prepare the estimate?

Introduction

Section 2

INTRODUCTION

Project Background

Pre-disaster hazard mitigation is about long-term or permanent measures designed to prevent or reduce physical, financial and human impacts of major natural disasters. The Federal Emergency Management Agency (FEMA) defines hazard mitigation as "sustained actions taken to reduce or eliminate long-term risk from hazards and their effects."

Natural disasters have become a costly business in the past 10-15 years, affecting all levels of government and also the insurance industry. Starting with Hurricane Hugo in 1989, costs of natural disasters and the number of declared disasters have gone way high compared to the historical record. The three most costly disasters in history have occurred in the past few years and include Hurricane Hugo, Hurricane Andrew (1992) and the Northridge Earthquake (1994).

Losses to the property/casualty insurance industry alone have amounted to $121.3 billion (adjusted for inflation) over the 12-year period from 1989 to 2000. That's nearly 130% more than the estimated $52.8 billion (adjusted for inflation) in losses over 39 years, going from 1950 to 1988.[1]

Table No. 1
Ten Costliest Natural Disasters

Event	Year	Inflation-Adjusted Losses (billions)
Hurricane Andrew	1992	$19.5
Northridge Earthquake	1994	$14.9
Hurricane Hugo	1989	$6.0
Hurricane Georges	1998	$3.2
Hurricane Betsy	1965	$2.9
Hurricane Opal	1995	$2.4
Oakland Fire	1991	$2.2
20-State Winter Storm	1993	$2.1
Hurricane Floyd	1999	$2.1
Hurricane Iniki	1992	$2.0

Source: ISO Property Claim Services unit.

Over time the number of natural disasters have also been climbing, though there is variation from year-to-year.

From 1989 to 2000, there have 362 disasters (defined as those with insured losses of more than $25 million, in 1997 dollars). That compares against 423 disasters from the previous 39 years, going from 1950 to 1988.

Many of the losses are attributed to increasing numbers of people living in areas prone to hurricanes and earthquakes. This problem is likely to continue to worsen as still more people choose to live in areas exposed to natural catastrophes, as shown by demographic projections by the insurance industry.

The same issues have also affected the federal government and FEMA. Numerous pieces of legislation have been passed recently to bring about improved strategic planning on the part of

[1] From "Facts and Figures about Catastrophes in the United States," found at www.isomitigation.com, the website for the Insurance Services Office, Inc. (ISO). ISO performs community ratings for fire protection and enforcement of building codes.

state and federal agencies. The trend has included an increased focus on *mitigation*, or policies and procedures designed to reduce the impacts of natural disasters.

Even more recently, given this nation's experience with the 2001 terrorist attack on the World Trade Towers in New York City – an event widely referred to as "911" – there's been a strong trend toward planning designed to reduce the impacts of terrorism.

This planning document, however, only deals with natural disasters affecting localities in the Mount Rogers Planning District. This region includes the counties of Bland, Carroll, Grayson, Smyth, Washington, and Wythe; cities of Bristol and Galax; and the 12 local towns. The business of anti-terrorism planning is still in its infancy, though in the future it is anticipated anti-terrorism planning will also become a required element of hazard mitigation planning.

Due to recent disastrous flooding in the region, the MRPDC was invited to submit an application to the Virginia Department of Emergency Management (VDEM) for FEMA funding to support this planning effort.

Purpose

This planning document is designed to meet the requirements of the federal *Disaster Mitigation Act of 2000*, particularly sections 201 and 322, discussed in further detail below.

The plan will provide local governments in the Mount Rogers region with a description of the region, its natural hazards and mitigation measures to reduce impacts from disasters. While the descriptions of hazards are addressed on a regional level, localized information is also presented where appropriate. The plan will:

- Make information available to residents, homeowners, businesses and local governments to help in making future decisions on building, growth and new development.
- Identify hazard vulnerabilities of buildings, structures and infrastructures to determine needed mitigation measures to protect against future damage.
- Provide details on strategies, by locality, for prioritizing and implementing hazard mitigation measures.

Key components of the hazard mitigation plan include the planning process, risk assessment, mitigation strategies, plan maintenance procedures and formal adoption by localities covered by the plan. See the narrative below (Disaster Mitigation Act: Part 201) for further detail on local hazard mitigation planning requirements.

The pre-disaster hazard mitigation plan is designed as a template for localities to follow when the next disaster strikes. In the future, as described under Part 206 of the DMA, these plans will be required before localities will be eligible to request assistance under the federal Hazard Mitigation Grant Program (HMGP).

"The DMA mitigation planning provisions, along with other sections of the Act, provide a significant opportunity to reduce the nation's disaster losses," as stated by FEMA.[2]

FEMA also anticipates that having hazard mitigation plans in place will help streamline the process. "The implementation of planned, pre-identified, cost-effective mitigation measures will make a major contribution to such streamlining."[3]

Legal Authority

Disaster Mitigation Act of 2000

The federal *Disaster Mitigation Act of 2000* serves as an amendment to the Stafford Disaster Relief Act. The new act provides new funding for hazard mitigation and adds mitigation planning to promote an integrated, cost-effective approach to mitigation.[4]

The Act went into law in October 2000. The Interim Final Rule on hazard mitigation planning criteria appeared in the Federal Register on Feb. 26, 2002.

The introductory section of the Federal Register notice explains that the "Act provides a framework for linking pre- and post-disaster mitigation planning and initiatives with public and private interests to ensure an integrated, comprehensive approach to disaster loss reduction. The language in the Act, taken as a whole, emphasizes the importance of strong state and local planning processes and comprehensive program management at the state level."[5]

The best hazard mitigation plans, according to FEMA, typically include two key elements:

1) Comprehensive risk and capability assessments that form a solid foundation for decision-making; and
2) Input from a wide range of stakeholders who would be active in the implementation of the recommended mitigations.

Disaster Mitigation Act: Part 201

Part 201 addresses mitigation planning, with the purpose of allowing "state, local, and Indian tribal governments to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from those hazards, and to establish a coordinated process to implement the plan, taking advantage of a wide range of resources."[6]

[2] From "State and Local Plan Interim Criteria under the Disaster Mitigation Act of 2000," FEMA publication, March 26, 2002.
[3] Ibid.
[4] From FEMA fact sheet on "Developing a Local Hazard Mitigation Plan."
[5] From Federal Register notice, Vol. 67, No. 38, in the Feb. 26, 2002 edition under Part III, Federal Emergency Management Agency.
[6] Ibid.

Hazard mitigation is defined as "any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards."[7]

The Act requires the state to review and, if necessary, update its hazard mitigation plan at least once every three years. For **localities** the review requirement comes once **every five years**. As a condition of receiving disaster assistance under the federal Hazard Mitigation Grant Program, localities must prepare and adopt a local hazard mitigation plan. The deadline for this requirement originally was set for Nov. 1, 2003. However, due to delays in developing and publishing specific criteria to implement the DMA, the Virginia Department of Emergency Management submitted a request to extend the original deadline to Nov. 1, 2004.[8]

Part 201 also gives details on the required contents of the hazard mitigation plans under § 201.6 (c). These include documentation of the planning process, localized risk assessments of natural hazards, description of the locality's vulnerability to the identified hazards, a mitigation strategy to reduce potential losses identified in the risk assessment, a process for plan maintenance, and documentation the plan has been formally adopted by the localities.

Local hazard mitigation plans can also be developed on a multi-jurisdictional basis, as is being done in the Mount Rogers region and other parts of Virginia. All plans must be submitted to the state Hazard Mitigation Officer for initial review and coordination. All plans also are subject to final review and approval by the appropriate FEMA regional office.

Disaster Mitigation Act: Part 206

Part 206 is concerned with federal disaster assistance declared on or after Nov. 23, 1988, with the changes made as a result of the legislation approved in 2000.

Under § 206.434 appear the new eligibility requirements for localities seeking federal Hazard Mitigation Grant Program (HMGP) assistance following declared federal disasters. Subsection (b)(1) states that, "for all disasters declared on or after November 1, 2003[9], local and tribal government applicants for sub-grants, must have an approved local mitigation plan in accordance with 44 CFR 201.6 prior to receipt of HMGP funding. Until November 1, 2003, local mitigation plans may be developed concurrent with the implementation of sub-grants."[10]

Planning Process

The planning process proceeded on several tracks, including background research by MRPDC staff, periodic meetings of an internal Hazard Mitigation team, interaction with all 20 local governments, monthly reports to the MRPDC Executive Committee, and input solicited from the Hazard Mitigation Advisory Team.

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[7] Ibid.
[8] Formal approval from FEMA had not yet been made at the time of this writing.
[9] See preceding narrative under Disaster Mitigation Act: Part 201 regarding the pending request to extend the original deadline to Nov. 1, 2004.
[10] From Federal Register notice, Vol. 67, No. 38, in the Feb. 26, 2002 edition under Part III, Federal Emergency Management Agency.

Background Research

MRPDC staff conducted research into the natural hazards known to affect the Mount Rogers region. These include drought, earthquakes, flooding, landslides, severe winter storms and ice, thunderstorms and lightning, tornadoes and hurricanes, wildfires and windstorms.

As described under Section 3, this work involved consultation with numerous sources found in internal files (past flood studies, water quality/quantity studies); Internet resources; special guides offered by FEMA; workshops and technical advice from the state Department of Emergency Management; surveys conducted with all 20 local governments; and input from an internal MRPDC committee that met periodically to track progress on the Pre-Disaster Hazard Mitigation project.

Part of the research also involved a field trip to a site south of Galax to see an on-the-ground demonstration of Firewise methods (for structures located in remote, wooded settings) and participation in a workshop on building disaster-resistant communities. Some amount of time also was spent digging out old newspaper events describing some disasters.

The assembled data formed the basis for the draft narrative developed for hazards and vulnerability assessment. The narrative cites data sources throughout the document, with key resources also listed under the References section.

Reports to MRPDC Executive Committee

MRPDC staff made regular reports and updates to the Executive Committee during that group's regular monthly meetings during the entire life of the Pre-Disaster Hazard Mitigation project, starting in October 2002 and continuing throughout 2003 and 2004.

For more details on the process and meetings held, please see Table No. 2, found below.

Hazard Mitigation Advisory Team

With the background research prepared in narrative form, the MRPDC took a more formal step to create the Hazard Mitigation Advisory Team in March 2004. This group was composed of a wide range of local government people, some state and federal agency people, and American Electric Power.

The Advisory Team was assembled to offer input on hazards and vulnerability assessment, the recommended mitigations, and the final report.

The composition of the Advisory Team leaned heavily toward local government to increase participation by that group and to create "buy-in" for the formal adoption process by each of the local governments. The success of the Hazard Mitigation project depends upon support and approvals by the local governments, as well as review and approvals by the Virginia Department of Emergency Management and FEMA.

Schedule of Meetings and Key Events

Table No. 2 gives an account of meetings held and individuals solicited for input during development of the Pre-Disaster Hazard Mitigation Plan for the Mount Rogers region. Please see the appendices section (Contributors to Plan Development) for a listing of those who gave input from local and state government and also the membership of the local Hazard Mitigation Advisory Team.

Table No. 2: Key Events and Public Participation
Pre-Disaster Hazard Mitigation Planning Process
Mount Rogers Region, Virginia

Date	Event	Details
10-03-02	MRPDC Executive Committee meeting	Executive Director reported the MRPDC had received $97,500 to develop a Regional Hazard Mitigation Plan.
11-07-02	MRPDC Executive Committee meeting	Executive Director reported he would be going around to visit each jurisdiction (counties and cities) to explain the rationale for the Regional Hazard Mitigation Plan. There was also a report attached on the major activities to be undertaken to complete the Plan.
12-05-02	MRPDC Executive Committee meeting	Executive Director reported the MRPDC would be hiring part-time help to assist with initial data gathering for the Regional Hazard Mitigation Plan.
01-09-03	MRPDC Executive Committee meeting	Staff reported on the hiring of Ron Sexton as part-time help for Hazard Mitigation and an upcoming meeting planned to consult with the U.S. Army Corps of Engineers.
01-15-03	Staff consultation with U.S. Army Corps of Engineers on flood-related issues.	Staff (Executive Director, planner, and Ron Sexton) and USACE people (Todd Boatman, Craig Carrington, Kyle Hayworth, Wayne Easterling, John Hunter, and Chip Hall) met to discuss USACE programs in flood mitigation and interest shown especially by the Town of Chilhowie for a preliminary flood-reduction study.
02-06-03	MRPDC Executive Committee meeting	Lou Brossy, a private forestry consultant, gave a program on the concept of the wildland/urban interface and its implications for Hazard Mitigation planning. Ed Stoots, from the Virginia Dept. of Forestry, and Bill Worrell, from the New River-Highlands RC&D Council, reported on their activities in fighting and preventing wildfires. Staff reported continuing activity in the information-gathering effort by Ron Sexton from the six counties, two cities, and 12 local towns.
02-11-03	Meeting hosted by City of Bristol for an update of its flood mitigation study	The group included representatives from USACE, FEMA Region III, Bristol, Tenn., Bristol, Va., MRPDC Executive Director and hazard mitigation planner. The group reviewed the progress to date of the full flood mitigation study by the USACE for the two Bristols.
03-06-03	MRPDC Executive Committee meeting	Staff reported on its efforts to photograph February 2003 flooding on the Middle Fork Holston River, an upcoming Hazard Mitigation workshop in Radford, the recent meeting with U.S. Army Corps of Engineers, and interest shown by the towns of Chilhowie and Marion for preliminary flood control studies by the Corps of Engineers.

03-21-03	Meeting with Mount Rogers Health District	The hazard mitigation planner met with Paige Boardwine re: the all-hazards planning work being done by the health district. This work is more oriented toward emergency response and management of drug supplies in event of need for mass public inoculations and related relief efforts.
04-10-03	MRPDC Executive Committee meeting	Staff reported Ron Sexton was nearly done with all of the initial interviews and surveys with all 20 local jurisdictions in the Mount Rogers region.
05-01-03	MRPDC Executive Committee meeting	No special report from staff, other than that the data-gathering work was continuing on the Hazard Mitigation plan.
08-07-03	MRPDC Executive Committee meeting	Staff reported the next phase for the Hazard Mitigation Plan would be data analysis and natural hazard mapping.
10-02-03	MRPDC Executive Committee meeting	Staff reported the interview process with the 20 local jurisdictions on Hazard Mitigation was complete.
10-09-03	Firewise demonstration project by the New River-Highlands RC&D Council	RC&D Council staff (executive director and forester) led an on-site program and tour of Firewise methods as applied to the Koji property along the Blue Ridge Parkway south of Galax. The Koji property was nearly lost in a recent woodland wildfire. The owners worked with the RC&D Council to cut back vegetation from the immediate area of the hostel and its outbuildings.
11-06-03	MRPDC Executive Committee meeting	Staff reported on the need to update the PDC's computer programming to assist with data analysis for the Hazard Mitigation Plan. The Commission voted to approve the purchase of mapping software (ARCView 8.3) for $3,658.
12-11-03	MRPDC Executive Committee meeting	Staff gave a Power Point presentation on the status of the Pre-Disaster Hazard Mitigation Plan, more federal flood disasters for the region, and the status of individual hazard vulnerability assessment.
01-08-04	MRPDC Executive Committee meeting	Staff presented an updated timeline for completion of the Regional Hazard Mitigation Plan and for the creation of the Hazard Mitigation Advisory Team.
02-05-04	MRPDC Executive Committee meeting	Staff reported the Regional Hazard Mitigation Plan is 30% complete.
03-11-04	Strategic planning to prevent wildfires	Hazard mitigation planner attended a strategic planning session for wildfire prevention in Carroll County. The New River-Highlands RC&D Council hosted the session at the Hillsville Volunteer Fire Dept.
03-24-04	Strategic planning to prevent wildfires	Hazard mitigation planner attended a strategic planning session for wildfire prevention in Grayson County. The New River-Highlands RC&D Council hosted the session at the Independence Volunteer Fire Dept.
04-08-04	MRPDC Executive Committee meeting	Staff reported the Hazard Mitigation Advisory Team would meet in May to review the Hazard Vulnerability Assessment section of the Plan.
05-21-04	Meeting of Hazard Mitigation Advisory Team	Team met for four hours to review the Hazard Identification and Vulnerability Assessment portion of the plan and to offer comment. Agencies pointed out the need for improved cooperation to speed the cleanup response following major snowstorms and the need to achieve similar standards in road-clearing practices handled through private contractors. There was some concern expressed about the potential for earthquakes in the region. There was extensive discussion of the impacts of flooding and the lack of Base-Flood-Elevation-determined floodplain maps for the region.
06-03-04	MRPDC Executive Committee meeting	Staff reported on the meeting of the Hazard Mitigation Advisory Team. Staff also reported PDC is moving into the second major phase of the Plan, which

		involves development of the region's Mitigation Strategy and Recommended Mitigations for each of the 20 local jurisdictions.
07-01-04	MRPDC Executive Committee meeting	Staff reported on its participation in the Virginia Hazard Mitigation Summit in mid-June in Charlottesville. Staff also reported the Hazard Vulnerability Assessment part of the Plan had been submitted to the state for preliminary review and comment.
10-07-04	MRPDC Executive Committee meeting	Staff presented essentially complete draft copy of entire Hazard Mitigation report for the Mount Rogers region. Staff also presented a Power Point presentation on methods used to estimate flood mitigation costs (elevation, relocation and demolition).
10-20-04	Meeting of Hazard Mitigation Advisory Team	Staff presented the proposed Hazard Mitigation Strategic Plan and its goals and objectives. The Advisory Team interacted with staff and participated in the ranking of regional objectives for Hazard Mitigation. There was extended discussion on mitigations for severe snowstorms and ice, as well as high winds. The Advisory Team questioned how well the Hazard Mitigation Plan would be enforced and whether local government would do its part (i.e., for enforcement of floodplain regulations). The Team felt local Emergency Operations Plans should be improved and kept up-to-date. The Team also pointed out the role of Low-Impact Development. Another suggestion was to urge volunteer fire departments and rescue squads to ensure adequate daytime response through use of paid professional responders.
11-04-04	MRPDC Executive Committee meeting	Staff presented outcome of the mitigation strategic planning done during the Oct. 20, 2004 session of the Hazard Mitigation Advisory Team. This included the prioritizing as it was produced on newsprint with adhesive dots and other explanations by staff.

Recommendations Made and Incorporation into Plan

Table No. 3 shows recommendations made throughout the planning process and how these comments were incorporated into the Pre-Disaster Hazard Mitigation Plan. This data is offered in response to FEMA requirements and also to present more details that reflect the back-and-forth nature of the public input process. Reading a finished copy of the Plan, in and of itself, would not fully reflect the input process without this added explanation.

Table No. 3: Incorporation of Public Comments into Plan
Pre-Disaster Hazard Mitigation Plan
Mount Rogers Region, Virginia

Public Comments	How/Where Incorporated
Language in the Hazard Mitigation Strategy needs to be stronger than "promote" to ensure the recommendations are implemented. Factors such as local politics and dislike of conflict could influence local enforcement authorities to adopt a lax approach to issues such as floodplain regulation.	This is incorporated indirectly. The Disaster Mitigation Act of 2000 requires localities to adopt pre-disaster hazard mitigation plans. Failure to adopt such plans means FEMA will deny disaster assistance to localities without hazard mitigation plans. See Plan Implementation section for a record of those localities that have passed resolutions to adopt the sections of the Plan that apply to specific localities. Also, it is our observation local officials are providing an appropriate level of enforcement (i.e., especially through local building codes). An enforcement mechanism also comes increasingly from the banking community, which is requiring homeowners to obtain flood insurance for properties located in the regulatory floodplain.
Flood mitigations should include Low Impact Development strategies to help reduce development pressures on floodplain areas.	There is a description of Low Impact Development strategies in the appendices. Also, LID has been incorporated into the general Mitigation Strategy (see Section 4) and into the recommendations for local mitigations.
Severe winter storms/ice appear in the Plan as a high-priority hazard, yet there is little discussion of winter storm mitigation.	Winter storm mitigation primarily consists of advance preparation and emergency response. Advance preparation recommendations appear in the appendices section and in the localized mitigation recommendations (see Section 4). Emergency response requires sufficient equipment, manpower and coordination among responders (i.e., road maintenance contractors to VDOT and electric power utilities). We encourage improved coordination among responders as part of the general Mitigation Strategy (see Section 4).
Local Emergency Operations Plans need to be reviewed and updated regularly. When disaster strikes, the EOPs seem to be ignored. The coordination needed among the localities, state and federal agencies, electric power companies, and emergency responders is often insufficient.	This recommendation is incorporated into the general Mitigation Strategy for the Mount Rogers region (see Section 4).

High winds and severe winter storms/ice are more important issues in the Carroll-Grayson-Galax area than flooding.	Local mitigation priorities for the Carroll-Grayson-Galax area have been reshuffled to place a high priority on mitigations for high winds and severe winter storms/ice. The priorities for these issues previously held a lower position in the local mitigation recommendations.
The new VDOT hazards warning system (primarily for high winds and fog) on Interstate 77 is not that useful because there's no place for truckers to get off the highway.	These observations have been noted in the local mitigation sections for the affected localities (Carroll and Grayson counties).
The original regional hazard ranking contained four categories. We recommend combining the two lowest priority groups (Low-Risk Hazards and Negligible Hazards).	Incorporated under Section 3 - Hazard Risk Assessments: Conclusions. Also, see Table No. 34: Risk Assessments.
VDOT deals with many localized landslides on steep slopes along State Rt. 16 in Smyth County and other locations. At least a dozen such incidents have happened in the past two years, and they immediately shut down the roadways.	We checked with VDOT's resident engineer for the area, and he indicated the landslides cause localized problems but are not of disaster proportions. We dropped further consideration of detailed landslide analysis for this report, due in large part to lack of basic geologic mapping data. This lack of data is addressed under the Mitigation Strategies (see Section 4).
Karst and sinkholes cause local headaches not mentioned in the report. The Ivanhoe post office fell in due to a sinkhole. The Town of Chilhowie knows it is losing 16 million gallons of water a month due to leaks in the system; the leaks go into the underlying karst.	We added this input under Section 3 (Hazards and Vulnerability Assessments: Karst and Sinkholes).
Earthquakes are bad business and can cause severe damage and disaster. Why are we ranking earthquakes as a low-risk disaster for the Mount Rogers region? Shouldn't we be much more concerned?	The historical record indicates earthquakes appear to pose only a moderate risk to the region. The worst known damages occurred in 1897 and broke chimneys, changed the flow of springs and created some fissures in the earth. Our HAZUS-based analysis also revealed relatively mild impacts should a repeat of the 1897 occur. See Section 3 (Hazards and Vulnerability Assessments: Earthquakes).
Wildfire protection for woodland homes will work well only if Firewise and similar methods are used and vegetation is cut back to a 150- to 200-foot radius around the property.	Already incorporated in report. See Section 3 (Hazards and Vulnerability Assessments: Wildfire) and Section 4 (regional and local mitigation strategies).
Wet snow and ice primarily affect overhead power lines. The average snowstorm does not usually create emergencies by itself. Underground power lines would mitigate the problem, but this is costly for the power companies. Ice is a problem because it tears down tree limbs, which in turn pull down power lines.	See Section 3 (Hazards and Vulnerability Assessments: Severe Winter Storms/Ice).

For major weather events, VDOT tracks conditions and makes e-mail updates to its people every two hours. Liquid chloride is used as a pre-treatment to prevent ice/snow buildup on highways. Post-storm recovery is governed by the ability to get roadways opened up and passable.	See Section 3 (Hazards and Vulnerability Assessments: Severe Winter Storms/Ice).
The Town of Chilhowie declined to go beyond a preliminary $100,000 flood study by the U.S. Army Corps of Engineers due to high cost ($527,000, on a 50-50 cost share) and little likelihood of identifying affordable alternatives. About a dozen properties still regularly get flooded; this problem should be addressed.	See Section 3 (Hazards and Vulnerability Assessments: Flooding, subsection on local flood history).
The Town of Damascus has not experienced disaster-level flooding in at least 10 years. In 1977, floodwaters rose to 4 feet high in the town hall. An earthen berm that protects the town park will one day, under the right conditions, force floodwaters into the town's central business district.	See Section 3 (Hazards and Vulnerability Assessments: Flooding, subsection on local flood history).
The City of Galax has flood problems due to undersized stormwater drain systems. The city does not qualify for federal aid because Galax does not participate in the National Flood Insurance Program. The city has studied NFIP closely but sees no advantage to joining the program.	See Section 3 (Hazards and Vulnerability Assessments: Flooding, subsection on local flood history). See also Section 4 (Hazard Mitigations) for the mitigation recommendations for the City of Galax.
Alternatives such as Low-Impact Development should be considered to reduce the likelihood of flooding and create more sustainable development patterns.	Incorporated under Goal 6 of the regional mitigation strategy found in Section 4.
Coping with natural disasters includes emergency response. Localities should work to make sure required Emergency Operations Plans are properly maintained, updated, and used as intended.	Incorporated under the regional mitigation strategy found in Section 4. This was a new category, so it appears as Goal 7 of the regional strategy.
Volunteer responder groups should take on paid professional responders to improve quality of emergency response, especially during daytime hours when volunteers are not always available.	Incorporated as an objective under Goal 7 of the regional mitigation strategy found in Section 4.

Hazards and Vulnerability Assessment

Section 3

BACKGROUND: Mount Rogers Region, Virginia

Physiography

The region covers 2,777 square miles and stands within both the Ridge & Valley and the Blue Ridge geologic provinces of Virginia. An image (Physiographic Regions of Southwest Virginia) is shown below, as adapted from the 2000 edition of the Virginia Statistical Abstract.

Map No. 1: Physiographic Regions of Mount Rogers Area

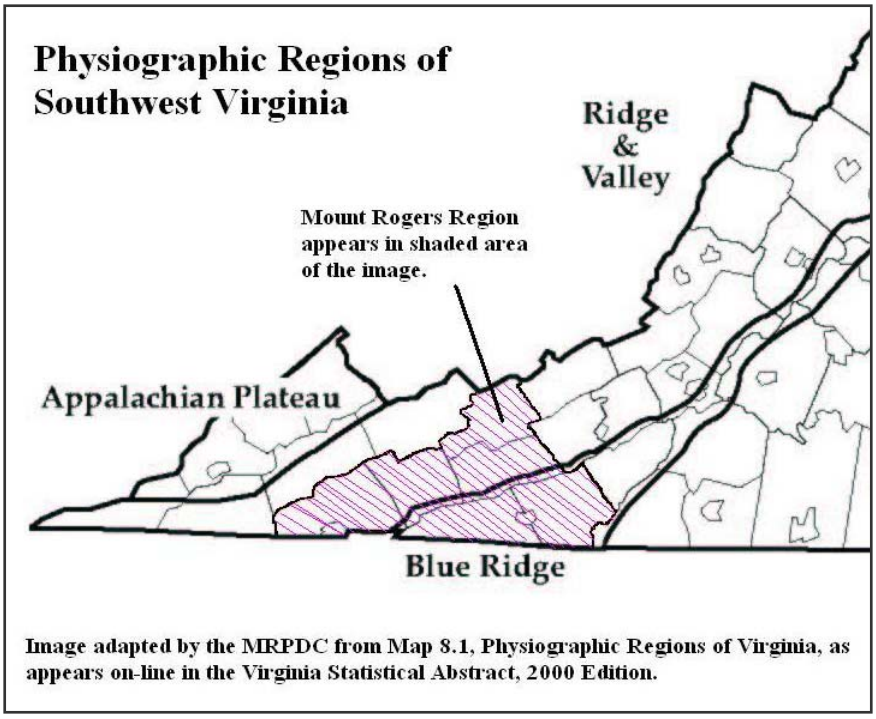


Image adapted by the MRPDC from Map 8.1, Physiographic Regions of Virginia, as appears on-line in the Virginia Statistical Abstract, 2000 Edition.

In the Ridge & Valley section, the land is characterized by valleys with low to moderate slopes underlain by carbonate rocks; this area starts in Bristol and runs in a northeasterly direction through Washington, Smyth and Wythe counties in a track toward Roanoke. Elevations generally range between 1,200 and 2,300 feet.

The Blue Ridge portion generally includes Grayson and Carroll counties. The land appears as a broad upland plateau with moderate slopes. The elevations are higher, generally ranging from 2,400 to 3,000 feet, and sometimes much higher. Mount Rogers itself, located near the junction of Grayson, Smyth and Washington counties, stands at more than 5,729 feet.

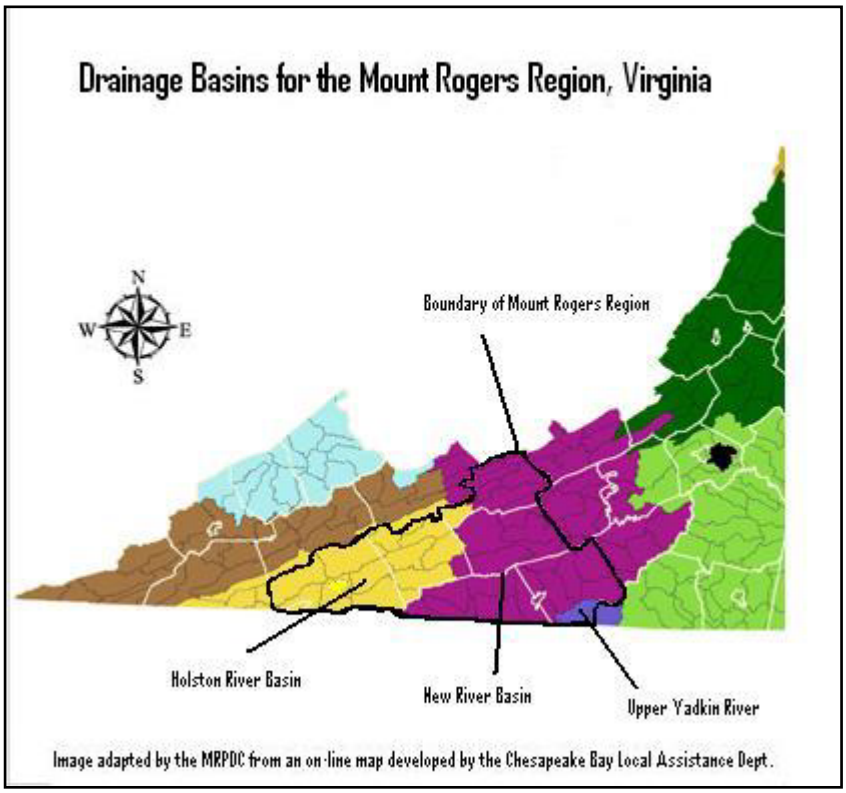
Natural Resources

The principal watersheds that drain the region include the Holston River system (including the North, South and Middle Forks), the New River, and a small portion of the Upper Yadkin River drainage.

The image, Map. No. 2: Drainage Basins for Mount Rogers Region, outlines the local region and its principal watersheds.

The Holston River Basin flows in a southwesterly direction to join with the Tennessee River system. The New River flows in a northerly direction into West Virginia, while the Upper Yadkin flows south into North Carolina. Much of the Mount Rogers region contains state and national forest, including the Mount Rogers National Recreation Area. The mountainous terrain generally precludes intensive development other than in the limited valley regions of the district.

Map No. 2: Drainage Basins for Mount Rogers Region



Mineral resources of the region include limestone, sandstone, granite, gravel, sand, shale, iron oxide, quartzite and salt. All are actively mined, according to the state Department of Mines, Minerals and Energy.

Historically important minerals in the region included coal, iron, lead, zinc, salt, gold, and gypsum. The richer mineral resources of the west have long since replaced much of the local mining activity in the Mount Rogers region.

Temperatures and Climate

The local region stands within a temperate climate zone influenced by the mountainous nature of southwest Virginia. Temperatures range from average lows of 15^0 F-25^0 F (in January) to average highs of 80^0 F-90^0 F (in July).[11] The differing elevations and lay of the land account for the range of differences in local weather.

Local annual precipitation also is highly variable. It ranges from 46”-62” annually in the highest mountains (Mount Rogers and surrounding area in the Blue Ridge) to up to 46” annually in other parts of the district.[12]

[11] Data from a series of maps on normal temperatures for Virginia and the United States from 1971-2000. Found at www.ncdc.noaa.gov/img/climate/normals.
[12] From Average Annual Precipitation map for Virginia, found at www.ocs.orst.edu/pub/maps.

Weather patterns and climate are influenced by the Appalachian and Blue Ridge mountain ranges, the direction of airflow and the effects of the major river valleys. Weather systems typically move from west to east. Cloud systems may pass up and over the mountains. As clouds rise, their moisture content condenses and falls as rain or snow; that often results in heavy precipitation on the western slopes of the mountains and little or no precipitation on the eastern (or rain shadowed) slopes of the mountains. Weather systems and storms also may follow the river valleys, running parallel to the mountain ranges.[13]

Political Boundaries

The Mount Rogers region, as designated by the Virginia General Assembly, includes six rural counties, two small cities and 12 local towns as follows in Table No. 4:

Table No. 4
Participating Localities: Mount Rogers Region

Participating Localities in the Hazard Mitigation Plan

Counties	Cities	Towns	
Bland	Bristol	Abingdon*	Independence*
Carroll	Galax	Chilhowie	Marion*
Grayson		Damascus	Rural Retreat
Smyth		Fries	Saltville
Washington		Glade Spring	Troutdale
Wythe		Hillsville*	Wytheville*

* Designates the county seats. Bland has no incorporated towns; its county seat is in the Bland community. Cities in Virginia are independent.

Key transportation systems within the region include the interstate highways (I-81 and I-77), U.S. Route 58 and U.S. Route 11, several local airports, some limited public transit service, and service from local taxicabs and Greyhound Bus Lines. The Norfolk Southern Railway is an important private hauler of freight. Passenger rail service presently is lacking in the region.

The region is variable in nature. It ranges from the very rural character of Bland County, with a population of nearly 6,900, to the rapidly urbanizing character of the largest county, Washington, with a growing population of more than 50,000. Grayson and Carroll counties are known as places for second home development, especially in areas with views of the New River. The two mid-size counties, Smyth and Wythe, with populations of roughly 30,000 each, serve as centers of commerce and manufacturing. The three largest towns, each with populations greater than 5,000, are Abingdon, Marion and Wytheville.

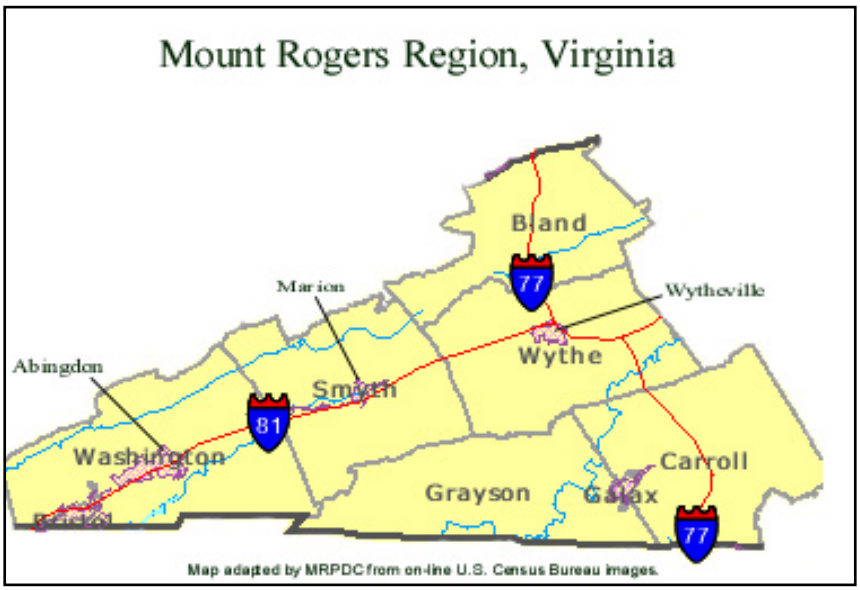
Population

The region-wide population numbered 188,984 as of the 2000 Census, up approximately 5.7% from the 1990 level of nearly 179,000. The growth is distributed unevenly within the region, with the greatest rate of increase occurring in Wythe, Carroll and Washington counties. In Bland, Smyth and Grayson counties, population remained stable from 1990 to 2000.

[13] From "Virginia's Climate" by the Virginia State Climatology Office at www.climate.virginia.edu.

Median family income for the region as of 1999 came to $36,930, which lags behind the statewide level of $54,169, as reported by the U.S. Census Bureau. Incomes in the Mount Rogers region have traditionally lagged behind statewide averages, along with the region's rate of new job creation. At the same time, unemployment generally runs higher than the statewide average, reflecting disparities between the high job growth rates in northern Virginia compared against rather lackluster performance in southwest Virginia.

Map No. 3: Jurisdictional Outline of Mount Rogers Region



Ethnically, the Mount Rogers region is dominated by whites (nearly 96%). The largest significant minority population (Hispanics, numbering 757, or 11% of the local population) is found in the City of Galax.

Economy

Manufacturing stands as one of the key employment sectors for the Mount Rogers region, though foreign competition and the North American Free Trade Agreement are undermining the sector. From 1991 through 2000, the region lost nearly 4,000 manufacturing jobs, with the total going from 28,158 to 24,274, a decrease of 14%.[14] The sector includes production of refrigeration and heating equipment, clothing, truck trailers and motor vehicle parts, glass products, furniture, wood products, hardware, sporting and athletic goods, and mining equipment.

The next largest employment sector falls in the services category, with more than 22,000 jobs in 2000, followed by retail trade, with more than 18,000 jobs in 2000. Employment in both sectors has grown over the past decade.

Farming offers relatively few jobs but remains an important industry that produced $161 million in earnings to the region in 2001.[15] Chief products include livestock, poultry, and burley tobacco. Though not classified as an agricultural product, Christmas trees, raised in the higher elevations, also are important to the region.

[14] Source: U.S. Bureau of Economic Analysis, Regional Accounts data (selection from Local Area Personal Income on employment, 1991 through 2000).
[15] Ibid, with data from Table CA45, Total Cash Receipts from Marketings (from farm income).

HAZARDS AND VULNERABILITY ASSESSMENT

This section reviews the primary natural hazards affecting the Mount Rogers Planning District region in southwest Virginia. Information is drawn from local, state and federal agencies; interviews with a wide range of people, including town managers, county administrators, engineers, emergency planners, GIS technicians, building officials, planners, public works directors, natural resource specialists; historical data; media accounts of major hazard events; and other resources as pertinent to this project.

Where possible the severity of given natural hazards are ranked according to standard measures, such as the Fujita scale for tornadoes and the Modified Mercali Intensity Scale for earthquakes. In some cases, detailed risk assessment on a local level is yet not possible due to lack of information; this became apparent in analysis of landslides, karst and sinkholes.

Historic information on natural hazard events is drawn from various sources including particularly the National Climatic Data Center, a national database that tracks storm and climatic events such as droughts, flooding, severe winter storms, thunderstorms and windstorms. The NCDC, while lacking in some respects, offers some of the best, most complete storm event data available.

Potential Hazards

The inland setting of the Mount Rogers region protects it from most coastal phenomena such as hurricanes, tropical storms and tsunamis. But the mountains, steep slopes, forests, and other geographic factors subject the region to many kinds of natural hazards. These include:

Dam Safety	Karst & Sinkholes	Tornadoes/Hurricanes
Drought	Landslides	Wildfires
Earthquakes	Severe Winter Storms/Ice	Windstorms
Flooding	Thunderstorms/Lightning	

The following section describes each of these hazards, their history, severity and impact, and likelihood of causing damage. Describing the hazards separately is problematic because natural hazards often combine. Flooding often follows severe winter storms. Thunderstorms contain lightning, high winds, and, rarely, tornadoes. Heavy rain can cause flooding and landslides. These descriptions, however, will provide detailed information and a basis for further analysis.

Analysis factors in this report are patterned after FEMA's *Multi-Hazard Identification and Risk Assessment* report (July 1997). It includes the following key elements:

- **Risk Assessment**: Potential losses associated with a hazard, defined as expected probability and frequency, exposure, and consequences.
- **Probability and Frequency**: Measures of how often an event is likely to occur.
- **Exposure**: Number, types, and values of property and life at risk of natural hazards.
- **Consequences**: Damages, injuries, loss of life, property, business and impacts to the environment from various hazards.

DAM SAFETY

Description

Dams exist to serve various functions within the Mount Rogers region. These include farm use, recreation, hydroelectric power generation, flood and stormwater control, navigation, water supply, fish or wildlife ponds, debris control, and tailings (from mining operations). In some cases, a single dam structure can serve multiple functions, such as generating hydroelectric power and providing recreational opportunities to boaters and fishermen.

State and federal governments regulate dam construction, maintenance and repair. On the state level, the Virginia Dam Safety Act of 1982 (and as amended effective July 1, 2002) serves as the guiding legislation. With certain exceptions, dams that must abide by this statute fall under one of two categories:

- Dams 25 feet tall[16] or higher, with a maximum storage capacity of 15 acre-feet[17] or more.
- Dams 6 feet tall or higher, with a maximum storage capacity of 50 acre-feet or more.

Dams not regulated by the state include those with an agricultural exemption (95 statewide), a federal license (114 statewide), a mining exemption (20 statewide), or a size exemption (879 in the state).[18]

Spillways are channels designed to keep water from overflowing the top of the dam and to prevent erosion at the bottom, or toe, of the dam. State law regulates spillway construction based on the dam's hazard classification and site classification.

The federal government maintains an inventory of dams through the National Dam Inspection Act of 1972 and, more recently, the Water Resources Development Act of 1996. Maintained by the U.S. Army Corps of Engineers, the inventory has been available on-line since January 1999. It is called the National Inventory of Dams[19], and its database covers roughly 77,000 dams, including several in the Mount Rogers region.

Dam Hazard Classification

The state and federal governments have adopted slightly different methods of classifying dam hazard potential. For the federal national inventory, dams are grouped into one of three categories, based on two criteria: the potential for loss of human life and the potential to cause economic, environmental and lifeline losses, in the event of a dam failure.

[16] Dam height is defined as the vertical distance from the streambed toe to the top of the dam.
[17] One acre-foot is defined as a measure of volume equal to one foot deep over a one-acre area.
[18] From presentation, "Virginia Dam Safety and Floodplain Programs," by Robert Cooper, senior environmental engineer, with the Dam Safety Program of the state Department of Conservation and Recreation. State Hazard Mitigation Summit meeting, June 2004.
[19] See the online version at http://crunch.tec.army.mil/nid.

The federal system appears as follows in Table No. 5:

Table No. 5: National Inventory of Dams
Hazard Classification

Hazard Potential	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low (L)	None expected	Low and generally limited to owner
Significant (S)	None expected	Yes
High (H)	Probable: one or more expected	Yes (but not necessary for this classification)

Source: Data dictionary found at http://crunch.tec.army.mil/nid/webpages/nid.cfm

Virginia's dam classification system varies in that it classifies the state-regulated dams into one of four categories, as follows in Table No. 6:

Under the state system, dam operation and maintenance plans, as well as inventory reports, must be completed every six years. Re-inspection reports, performed by professional engineers, must be made at 2-year intervals for Class I dams and 3-year intervals for Class II dams. In addition, dam owners must inspect their own dams and submit annual reports in years when professional inspections are not required.

Table No. 6: Virginia Dam Safety Program
Hazard Classification

Class	Loss of Human Life	Economic Impact	Dam Owner Responsibility
I	Probable	Excessive	Operation & maintenance application Emergency action plan Re-inspection report
II	Possible	Appreciable	Operation & maintenance application Emergency action plan Re-inspection report
III	None expected	Minimal	Operation & maintenance application Emergency action plan Inventory report
IV	None expected	No loss to others	Inventory report

Source: Presentation, "Virginia Dam Safety and Floodplain Programs," by Robert Cooper, senior environmental engineer, Virginia Dam Safety Program. June 2004.

Dam Hazard History

In the Mount Rogers region there has been some history of dam failures over the years, although obtaining a complete record has proven difficult for the purposes of this Hazard Mitigation report. Regulatory agencies at the state and federal governments are reluctant to release full information on dams, inspection histories, and known hazards. Hazard classifications, in and of

themselves, serve as a bureaucratic indicator of *potential* hazard in the event of dam failure, but the classification does not reflect the present physical condition or status of any given dam.[20]

In Bland County, a failure in the **Crab Orchard Creek Dam** at about noon on January 29, 1957 flooded the community of Bland as a result of three days and nights of continuous rains.[21] The water went through a crack that opened when a slate hillside on one side gave way.[22] While no one was hurt, the flooding destroyed or severely damaged many homes and also swept away outbuildings, cars, fences, machinery, livestock, and household equipment. The flooding also damaged several downtown businesses. One house floated a mile downstream and came to rest against a bridge and other wreckage. One home was tilted on edge and carried 200 yards downstream to come to rest against a concrete bridge in the community. Estimated damages came to $500,000. The local unit of the American Red Cross provided $30,363 in emergency aid, with nearly $22,395 going for structural repairs.[23]

Image No. 1: Dam Disaster in Bland County, 1957

The photo at left, Image No. 1, shows the tilted home (see far right of image) that was swept 200 yards downstream during the Crab Orchard dam failure and flood of 1957.

Please see more images of the 1957 dam disaster below.[24]

Some now believe that Interstate 77, which passes between the dam and the community, will protect Bland from a similar occurrence in the event the dam should fail again. However, the state's hazard rating on the dam was upgraded in 2004 from significant hazard (Class II) to high-hazard status (Class I). The dam owner hired an engineer as part of an effort to show why the Crab Orchard Creek Dam does not deserve a Class I rating.

Another locally known dam failure occurred on Christmas Eve in 1924, when the **muck dam at Saltville** broke and flooded the community of Palmertown, killing 19 people and dislodging

[20] From personal communications with regulators with the state Department of Conservation and Recreation and from explanations as posted on state and federal Internet websites.
[21] From newspaper story, "Crab Orchard Lake Waters Sweep Through Bland," in the *Bland Messenger*, January 31, 1957. From archives of the Bland County Historical Society.
[22] From oral history given by a local resident and obtained by Rocky Gap High School.
[23] From newspaper story, "Final Total Red Cross Expenditures Following Flood Reach $30,363.02," in the *Bland Messenger*, March 21, 1957. From archives of the Bland County Historical Society.
[24] All photos shown for the 1957 dam break in Bland were provided by courtesy of the Bland County Historical Society.

several homes from their foundations. According to at least one news account at the time, the dam failure occurred due to human intervention; police accused a 27-year-old man named Roy Patrick of using dynamite to blow up the dam.[25]

Image No. 2: Downtown Bland, 1957
The business district in Bland following the failure of Crab Orchard Creek Dam (see image below).

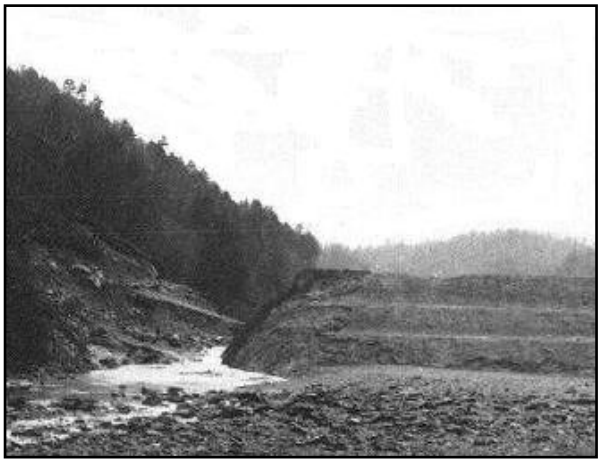


Image No. 3: 1957 Dam Break in Bland
Days of constant rainfall loosened the slate mass of the hill at one side of the dam. The slate began sliding, causing the break in the dam.

Risk Assessment

For the purposes of hazard mitigation, this report takes note of dams classified with a potential for high or significant hazard in the event of failure, as defined under the National Inventory of Dams (for more information, see the previous narrative under the description section). Those dams classified with a low hazard potential were not considered.

High-hazard and significant-hazard dams (14 total) in the Mount Rogers region primarily consist of earthen structures built for recreational use. Four of the dams are used to generate hydroelectric power, although three of those also offer recreational uses. Several of the dams combine recreational uses with flood or stormwater control. Clear Creek Dam in Washington County, near the City of Bristol, serves multiple uses. These include flood and stormwater control, recreation, water supply, and other uses.

Of the 14 previously described dams, six come under federal regulations. These include the Byllesby Dam and Buck Dam on the New River in Carroll County, Hale Lake Dam in Grayson County, and Beaver Creek Dam, Clear Creek Dam and Edmondson Dam (which has been breached), all located in Washington County. These dams mainly serve to provide hydroelectric power or flood control.

[25] From newspaper story, "Charged with Blowing Dam," in the *Marion News*, January 1925. On file in the historical archives at Smyth-Bland Regional Library in Marion.

Due to recent changes in state dam safety regulations, two more of the region's dams – Laurel Creek Dam and Fields Dam, both in Grayson County – will be required to prepare Emergency Action Plans. EAPs, contained in county emergency operations plans to govern emergency response for natural and man-made disasters, define roles by dam owners and emergency services personnel for monitoring of dams' physical condition and notification of downstream communities in the event of flooding or potential dam failure.

For more details on all the region's dams classified as High Hazard and Significant Hazard, please see the table found at the end of this section.

Probability and Frequency

There is no way to predict the likelihood of a dam failure, since failures relate to the structure, condition, age, maintenance, and natural forces (and storm events) that can affect the integrity of the dam. A well-maintained dam classified as a High Hazard structure may in fact pose little risk to downstream community.[26] Detailed information on the condition of dams is not available from local, state or federal sources.[27]

Dam regulation first began in this country due to failures of poorly built dams in the early part of the 20th century. More regulations came following a series of dam failures in the 1970s. Legally, dam owners hold the responsibility for the safety, upkeep, and maintenance of dam structures. Of the 75,000 dams listed by the National Inventory of Dams, 95% fall to the regulation of state governments.[28]

The possibility of failure generally increases with age, with many dams designed for an effective life of 50 years. Six of the 14 high-hazard and significant-hazard dams in the Mount Rogers region are at least 50 years old. Dams with known structural problems can be given conditional operating permits, which point to the need to make improvements. There are 30 such dams in Virginia, with none located in the Mount Rogers region.[29]

Exposure

The following data is presented, based on available data, in Table No. 7. The information was obtained mainly from local emergency services coordinators in the Mount Rogers region. Regulatory authorities have declined to make much information available, as previously noted.

[26] This is one reason why dam hazard classification systems can be misleading.
[27] This comes from communications with the regulatory community (primarily, officials with the state Dam Safety Program housed within the Department of Conservation and Recreation), review of the literature, and review of state and federal data that tracks the ownership, location, size, and hazard ratings for dams but that suppresses inspection and status reports.
[28] From *Introduction to Dams*, a publication of the Association of State Dam Safety Officials, available at www.damsafety.org.
[29] From "Aging, flawed Virginia dams raise worries," news story in the *Richmond Times-Dispatch*. March 15, 2004.

Table No. 7: Property Exposure Data for Downstream Communities
Mount Rogers Region, Virginia

Dam and Location	Nearest Downstream Community	Structures at Risk	Notes
Crab Orchard Creek Dam (Bland Co.)	Bland	19 occupied homes 18 businesses	Based on 1995 Emergency Operations Plan for Bland County. The state now regulates this as a Class I dam.
Byllesby Dam (New River, Carroll Co.)	Ivanhoe Austinville	N/A	Data not available. This is a federally regulated hydroelectric dam.
Buck Dam (New River, Carroll Co.)	Ivanhoe Austinville	N/A	Data not available. This is a federally regulated hydroelectric dam.
Stewarts Ck-Lovills Ck Dam (Carroll Co.)	Mt. Airy, N.C.	N/A	
Hidden Valley Estates Dam (Grayson Co.)	Not given	N/A	
Laurel Creek Dam (Grayson Co.)	Fox Creek	N/A	Downstream risks have not yet been assessed due to prior size exemption for this dam. The state will require an EAP under new rules adopted in 2002.
Fields Dam (New River, Grayson Co.)	Fries	N/A	Downstream risks have not yet been assessed due to prior size exemption for this dam. The state will require an EAP under new rules adopted in 2002.
Hale Lake Dam (Wolf Pen Branch, Grayson Co.)	None given	N/A	Data not available. This is a federally regulated fish & wildlife dam.
Hungry Mother Dam (Smyth Co.)	Marion	Campground A few houses	
Beaver Creek Dam (Washington Co.)	Bristol	N/A	Data not available. This is a federally regulated flood control dam owned by TVA.
Clear Creek Dam (Washington Co.)	Bristol	N/A	Data not available. This is a federally regulated flood control dam owned by TVA.
Edmondson Dam (M.F. Holston River, Washington Co.)	Mock Mill	N/A	Data not available. This is a federally regulated hydroelectric dam.
Hidden Valley Lake Dam (Brumley Creek, Washington Co.)	Duncanville	N/A	
Rural Retreat Dam (S. Fork Reed Creek, Wythe Co.)	State Rt. 749	N/A	

Sources: National Inventory of Dams maintained by the U.S. Army Corps of Engineers; consultations with local emergency services coordinators; consultations with Virginia state dam safety officials.

Consequences

Catastrophic dam failure can result in severe property damage and loss of life. Some major events involving dam failures cited in the literature[30] are shown in Table No. 8.

Table No. 8: Major Dam Disasters Nationwide and in Virginia

Date	Dam and Location	Deaths	Estimated Damages
May 31, 1889*	South Fork Dam, at Johnstown, Pa.	**2,209**	$17 million.
Mar. 12-13, 1928*	St. Francis Dam, north of Los Angeles, Ca.	**> 450**	1,200 homes destroyed, 10 bridges washed out.
Feb. 27, 1972	Buffalo Creek, W. Va.	**125**	More than $400 million. Caused by failure of a coal waste embankment.
June 9, 1972	Canyon Lake Dam, at Rapid City, S.D.	**> 230**	$164 million in property damages.
June 5, 1976	Teton Dam, Idaho	**11**	More than $1 billion.
June 22, 1995	Timberlake Dam, near Lynchburg, Va.	**2**	Unknown. Dam rebuilt at cost of nearly $1 million.
1999	Hurricane Floyd, eastern Va.	**0**	Floyd breached 13 dams and damaged highways in Gloucester County and James City County.

* These dam failures, along with many others, occurred many years before government regulations came into effect.

Legally dam owners must properly monitor and maintain their dams, while state and federal regulators act as overseers and enforcers. But the Association of State Dam Safety Officials and others point out that the effectiveness of regulation vary among states and dam owners often lack the financial resources necessary to undertake costly repairs.

Events that can lead to dam failures include the following: overtopping, structural failure, loss of stability in the dam's foundation, cracking in the dam structure from natural settling, poor upkeep, and piping (resulting from improper filtration in the dam structure, allowing seepage and passing of soil particles to gradually create sinkholes in the dam).[31]

[30] Information from the Association of State Dam Safety Officials and the American Society of Civil Engineers and "The Need for Dam Safety Standards and Regulation," by John Moyle, *Lakeline* newsletter. Fall 2002.
[31] From *Introduction to Dams*, from the Association of State Dam Safety Officials, found at www.damsafety.org.

DROUGHT

Description

In simple terms, drought can be defined as "a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and man over a sizeable area."[32] Drought can also be defined in terms of its effects and divided into categories, as suggested by FEMA:[33]

> *Meteorological drought*: Defined solely on the degree of dryness, expressed as departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
>
> *Hydrologic drought*: Related to the effects of precipitation shortfalls on streamflows and reservoir, lake, and groundwater levels.
>
> *Agricultural drought*: Defined mainly in terms of soil moisture deficiencies relative to water demands of plant life, usually crops.
>
> *Socioeconomic drought*: This occurs when the demand for water exceeds the supply as a result of a weather-related supply shortfall.

Drought occurs as part of the regular climatic regime in virtually all climates. Its causes are complex and not readily predictable, especially in variable climates. Compared to storm events such as hurricanes and floods, drought has a slow onset and can last for months, years or even decades. Estimated dollar losses caused by drought can far exceed those of major storm events.[34]

Some measures of drought, also known as drought indices[35], include:

- **Percent of Normal**: Calculated by dividing actual precipitation by normal precipitation (usually defined as the 30-year average) and multiplying by 100%. Effective for a single region or a single season. A disadvantage is the average precipitation is often not the same as the median precipitation.
- **Standardized Precipitation Index**: Index based on the probability of precipitation for any time scale. This is used by the National Drought Mitigation Center. It can provide early warning of drought, can assess drought severity and is less complex than some indices.
- **Palmer Drought Severity Index**: This is a measure of soil moisture and was the first comprehensive drought index created in the country, in 1965. It works best in areas of even topography but is less suitable for mountainous areas or places with frequent climatic extremes. Palmer values may lag emerging droughts by several months.

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[32] Quoted from definitions of drought, USGS Drought Watch, at www.md.water.usgs.gov/drought/define.html.
[33] Hydrologic hazards section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997.
[34] "A Comparison of Drought, Floods, and Hurricanes in the U.S.," by the National Drought Mitigation Center, at www.drought.unl.edu/risk/us/compare.htm.
[35] From section on drought indices, by the National Drought Mitigation Center, at www.drought.unl.edu.

- **Crop Moisture Index**: A derivative of the Palmer Index. It reflects moisture supply across major crop-producing regions. It is not intended to assess long-term droughts.
- **Deciles**: This approach groups monthly precipitation events into deciles so that, by definition, "much lower than normal" weather cannot occur more than 20% of the time. This provides an accurate statistical measurement of precipitation, but its accuracy relies on a long climatic data record.

History

The U.S. Geological Survey has noted four major droughts statewide since the early 1900s. These occurred in 1930-1932 (one of the most severe droughts on record for the state), 1938-1942, 1962-1971 and 1980-1982 (the least severe). Other sources suggest the record is somewhat different for the Mount Rogers region. Table No. 9, shown below, gives a brief review of the some of the major droughts that have affected southwest Virginia.

Table No. 9: Droughts In Southwest Virginia

Date	Location	Details	Impact
2-12-03	Carroll, Grayson, Smyth, large parts of SW VA	**USDA disaster declaration** due to severe drought for 46 counties. Primary disaster for Carroll, Grayson, Smyth counties. Contiguous declaration for Galax and Washington County.	Low-interest emergency loans for farmers.
July and August 2002	Statewide	**State emergency drought declaration** for July and August. USDA disaster declarations for Bland, Carroll, Grayson, Smyth, Wythe counties.	Significant crop damage. Reduced streamflow and groundwater levels.
9-1-99 (NCDC)	Bland, Carroll, Galax, Grayson, Smyth, Wythe, large parts of SW VA	Dry conditions began in July 1998, subsided for several months, then returned in June 1999 and through early Sept. Drought largely ended due to heavy rain from remnants of Hurricane Dennis on Sept. 4-5, 1999.	$8.25 million in crop damage. Very low water levels in creeks, streams and rivers.
July to October 1998 (NCDC)	Bland, Carroll, Galax, Grayson, Smyth, Wythe, large parts of SW VA	Dryness began in July, subsided in August, resumed in September. Low water levels in creeks, streams, rivers, lakes and some shallow wells.	Water levels low. $7.7 million crop damage.
9-1-95 (NCDC)	Bland, Carroll, Galax, Grayson, Smyth, Wythe, large parts of SW VA.	A drought that started earlier in the summer peaked in many sections of the state during the first two weeks of Sept. **State of emergency** declared. Widespread rainfall on Sept. 17 helped to alleviate the dryness.	Crops damaged. Many lakes and rivers with well-below normal water levels.
1988	Mount Rogers region	Drought based on the Palmer Drought Severity Index, with the region in severe drought up to nearly 50% of the time. One of the worst droughts on record for the nation (1988-1989).	
1954-1956	Mount Rogers region	Drought based on the Palmer Drought Severity Index. Region in severe drought up to nearly 40% of the time.	
1928-1934	Mount Rogers region	Drought based on the Palmer Drought Severity Index. Region in severe drought up to nearly 20% of the time.	

Source: Storm events database of National Climatic Data Center; Virginia Dept. of Emergency Management; National Drought Mitigation Center; USDA disaster declarations.

Maps prepared by the National Drought Mitigation Center[36] show the extent and severity droughts based on data from the Palmer Drought Severity Index. These maps cover the period from 1895 to 1995 and are subdivided into various time periods. For the Mount Rogers region the worst period came in 1988, with the region in severe drought 40%-49.99% of the time. Over the long-term severe drought conditions in the Mount Rogers region occurred only up to 10% of the time.

Risk Assessment

Probability and Frequency

In recent years, major agricultural droughts have occurred five times from 1995 through 2003. The historical record is not as well developed for the years prior to 1995, though major droughts are known to have occurred in 1928-1934, 1954-1956 and in 1988.

For the 100-year period from 1895 to 1995, the region has been estimated to experience drought less than 10% of the time.

Exposure

History shows drought conditions reaching disaster proportions can affect the entire Mount Rogers region. For some parts of the region, especially in Carroll County, well development is difficult and often produces a dry hole.

Consequences

The impacts appear to have the greatest impact for the farming community. In these cases the U.S. Department of Agriculture makes damage assessments and provides financial aid to qualifying farmers through the local farm service agencies.

Water issues also are a concern for the general public, local governments, business and industry. Several engineering studies from the mid- to late-1990s, as well as a 1996 health department survey, identified issues regarding water quantity, water quality and reliability of supply. In the unincorporated areas, most parts of the region depend upon groundwater supplies. The reported problems include low quantity, poor quality (due to mineral or bacterial content), turbidity, petroleum contamination and dry holes. Limited quantities restrict fire-fighting capabilities. Inadequate or limited water supplies also restrict future growth potential for business and industry. (Please see Table No. 10, on the next page, for details).

[36] Located at the University of Nebraska at Lincoln and also at www.drought.unl.edu.

Table No. 10: Water Problems Reported to the Mount Rogers Health District[37]	
Bland County	**Complaints**
Little Creek area	Bacteria in recently drilled wells.
Hollybrook	Mineral quality/iron bacteria. Cisterns used for some supplies.
Seddon	Appearance of dry wells. Cisterns used for some supplies. Mineral quality.
Waddletown	Poor quality with some wells and springs. Cisterns used for some supplies.
Laurel Creek/Dry Fork	Poor quality in some springs and wells.
Ceres	Poor quality in springs and iron bacteria in wells.
Bastian/Hicksville Crandon/Mechanicsburg	Mineral quality/iron bacteria concerns.
Carroll County	**Complaints**
Paul's Creek (Cana area) Dugspur (Rt. 753) Star (Rt. 1105) Woodlawn Piper's Gap Fancy Gap (Rt. 683) Chestnut Yard Rt. 645 (below Laurel Fork) Short Creek (Rt. 640/I-77)	Iron, turbidity, low-yield wells.
Grayson County	**Complaints**
Old Town – Fries Hill	High iron levels.
Flatwood Community	Many wells are drilled deep. Many dry holes found.
Helton/Cabin Creek Area	Well construction difficult due to rock formations.
Other Comments:	Many springs used as private water supplies, especially in western areas of the county. Many springs have bacteria contamination.
Smyth County	**Complaints**
Walker Mountain area	High iron/sulphur content.
Washington County	**Complaints**
Mendota (Rt. 802 area)	High iron/sulphur content in private water supplies.
Rt. 91 (S.F. Holston to Rhea Valley)	Low-yield wells and bacteria contamination.
Wythe County	**Complaints**
Poplar Camp, Crockett, Gateway Trailer Park (Grahams Forge), Rosenbaum Chapel area	Petroleum contamination.
Sand Mountain area	Dry holes and low-yield wells.
Stony Fork area	High iron/sulphur levels.

[37] From *Drinking Water Supply Problems in Southwestern Virginia: Virginia Department of Health Survey Information*. August 1996.

EARTHQUAKES

Description

An earthquake can be defined as a sudden motion or trembling caused by an abrupt release of accumulated strain on the tectonic plates that comprise the earth's crust.[38] The theory of plate tectonics has been described since 1967 and is based on the idea the earth's crust is composed of several major plates that move slowly and continuously, at times bumping and grinding against each other and at other times creating separations.

The tectonic plates are thought to bump, slide, catch or hold as they move together. An earthquake happens when faults located near plate boundaries slip when the stress against the rock formations becomes too great. This sudden movement results in surface faulting, ground failure and tsunamis.

Surface faults are thought to occur in various forms, including strike-slip faults, normal faults (with strong vertical movement), and reverse (thrust) faults (mainly horizontal movement). *Ground failure* is expressed through liquefaction, when coarse soils lose their strength and act like fluids flowing over the landscape. Ground failure created by liquefaction includes lateral spreads, flow failures (the most catastrophic form), and loss of bearing strength (causing buildings to settle and tip). *Tsunamis* are phenomena associated with the west coast and are not considered further in this report.

Earthquakes are described in various fashions, including by intensity and magnitude. Intensity is defined as a measure of earthquake effects (see Table No. 11, below) at a particular place on humans, structures or the land. Magnitude is a measure of the strength of an earthquake or the strain energy released by it (originally defined by Charles Richter in 1935).

History

Sources such as the Virginia Department of Mines, Minerals and Energy describe the statewide risk of earthquakes as moderate, in keeping with most other states in the eastern seaboard of the United States.

More than 300 earthquakes have been documented in Virginia since 1774. Of these, 18 have been reported with intensities of VI or greater. Much of the activity has been in the southwest and eastern parts of the state. Counties and cities that have experienced earthquakes of intensity VI and higher include Smyth, Washington and Wythe in the local region. Local earthquake history is described by Stover and Coffman[39] and also by the U.S. Geological Survey, through its Earthquake Hazards Program.[40] These events appear in Table No. 11 shown below.

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[38] Seismic hazards section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997. Available through www.fema.gov under the Hazards section.
[39] "Seismicity of the United States, 1568-1989," (revised). USGS professional paper.
[40] "Earthquake History of Virginia," found at www.neic.usgs.gov/neis/states/virginia/virginia_history.html.

Table No. 11: Earthquakes In The Mount Rogers Region
Date/Location, Intensity, and Description

Date/Location	Intensity	Description
March 9, 1828 Southwest VA	V (MM)	Felt over 218,000 sq. miles, from Pennsylvania to South Carolina and the Atlantic coastal plain to Ohio. Doors and windows rattled.
April 29, 1852 Wytheville	VI (MM)	Severe earthquake shook down a chimney near Wytheville and shook down tops of chimneys at Buckingham Courthouse. Homes shook in Staunton. A brick fell from a chimney in Davie County, N.C.
Aug. 31, 1861 Southwest VA	VI (MM)	Epicenter in extreme southwest Virginia or western North Carolina. Bricks fell from chimneys at Wilkesboro, NC. Felt from Washington, D.C. to the Midwest and south to Columbus, GA.
Sept. 1, 1886 South Carolina	V (MM)	Epicenter in Charleston, S.C., with estimated intensity of X. Caused minor structural damages in various parts of Virginia (fallen plaster and chimneys, cracked walls, broken windows).
May 3, 1897 Giles County	VII (MM)	Greatest severity at Radford, where some chimneys were destroyed and plaster fell from walls. Felt in most of southwest Virginia and in a region of 89,500 sq. miles.
May 31, 1897 Giles County	VIII (MM)	Largest known earthquake originating in Virginia in history. Felt over 280,000 sq. miles. Largest effects felt from Lynchburg to Bluefield, W. Va. and from Giles County south to Bristol, Tenn. Many downed chimneys, changes in flow springs and appearance of some earth fissures.
Feb. 5, 1898 Wytheville or Pulaski	VI (MM)	Earthquake felt over 34,000 sq. miles. Bricks fell from chimneys and furniture shifted in a few houses. Effect felt throughout southwest Virginia and south to Raleigh, N.C.
April 23, 1959 Giles County	VI (MM)	Several chimneys were damaged, plaster cracked and pictures fell from walls in Eggleston and Pembroke. Felt over 2,900 sq. miles in southwest Virginia.
Nov. 11, 1975 Giles County	VI (MM)	Windows were broken in Blacksburg and plaster cracked at Poplar Hill (south of Pearisburg, Giles County). Also felt in Pulaski County.
Sept. 13, 1976 Carroll County	VI (MM)	One of the most persistent areas of activity in recent years, with five small earthquakes felt near Hillsville. Effects felt in the Carolinas and West Virginia.

Source: "Virginia's Largest Earthquakes," at www.geol.vt.edu/outreach/vtso/VA-Eq.html, data from Virginia Dept. of Mines, Minerals and Energy, and the U.S.G.S. Earthquake Hazards Program.
Note: MM stands for Modified Mercali scale for earthquake intensity.

One notable earthquake occurred in May 1897 and was based in Giles County. It was the largest Virginia-based earthquake in recorded history. Chimneys were shaken down throughout southwest Virginia, including in Wytheville and as far west as Knoxville, Tenn. Effects of the earthquake were felt from Georgia to Pennsylvania and from the Atlantic Coast to Indiana and Kentucky. The effects were strong at Pearisburg, where brick walls cracked and some earth fissures appeared. The magnitude of this quake has been estimated at VII and VIII on the Modified Mercali intensity scale (see Table No. 12). This event, felt over 11 states, is described as the third largest earthquake in the eastern part of the country in the past 200 years.

On a regional level, the largest known earthquake occurred in 1886 and was based in Charleston, S.C. With an estimated intensity of X, the quake killed 60 people and damaged buildings extensively throughout Charleston. Structural damage was reported to buildings in Alabama, central Ohio, eastern Kentucky and southern Virginia and western West Virginia.[41] In the local region plaster fell from walls in Abingdon. In other parts of Virginia, damages included fallen chimneys, broken windowpanes and cracked walls. The event created much disruption in Richmond, including a prison riot and police and militia called out to restore order.[42]

Table No. 12: Modified Mercali Scale Of Earthquake Intensity

Scale	Intensity	Description	Max. Accel. (mm/sec)
I	Instrumental	Detected only on seismographs.	< 10
II	Feeble	Some people feel it.	< 25
III	Slight	Felt by people resting, like a truck rumbling by.	< 50
IV	Moderate	Felt by people walking.	< 100
V	Slightly Strong	Sleepers awake. Church bells ring.	< 250
VI	Strong	Trees sway. Suspended objects swing. Objects fall off shelves.	< 500
VII	Very Strong	Mild alarm. Walls crack. Plaster falls.	< 1000
VIII	Destructive	Moving cars uncontrollable. Masonry fractures. Poorly constructed buildings damaged.	< 2500
IX	Ruinous	Some houses collapse. Ground cracks. Pipes break open.	< 5000
X	Disastrous	Ground cracks profusely. Many buildings destroyed. Liquefaction and landslides widespread.	< 7500
XI	Very Disastrous	Most buildings and bridges collapse. Roads, railways, pipes and cables destroyed. General triggering of other hazards.	< 9800
XII	Catastrophic	Total destruction. Trees fall. Ground rises and falls in waves.	> 9800

Source: Town of Holden Beach, N.C. Community-Based Hazard Mitigation Plan, July 2003.

Unlike other types of earthquakes, the Charleston quake occurred within a tectonic plate rather than along the boundary of a plate (as in the 1906 San Francisco Earthquake). Intraplate earthquakes are known to occur in the eastern and central parts of the United States, though these forms of earthquakes are not well understood. For the southwest Virginia region, the intensity of 1886 Charleston earthquake is estimated at V on the Modified Mercali scale.

[41] From the Earthquake Hazards Program at www.neic.usgs.gov/neis/eq_depot/usa/1886_09_01.html.
[42] From the 1994 earthquake brochure by the Virginia Dept. of Mines, Minerals and Energy.

Risk Assessment

Probability and Frequency

For the Mount Rogers region, the likelihood of earthquakes appears to be moderate, based on measurements related to maximum ground acceleration and as described by FEMA.[43] This data is incorporated into probabilistic ground motion maps published in the 1994 edition of the National Earthquake Hazards Reduction Program's *NEHRP Recommended Provisions*.

The southwest Virginia region faces a moderate chance of experiencing earthquakes. While recent history shows some part of the region experiences earthquakes roughly once every 18 years, the resulting damage has been relatively minor.

Exposure

The entire Mount Rogers region is subject to the effects of an earthquake, as shown by the historical record from larger events such as the Giles quake from May 1897.

The Mount Rogers region in total covers 2,786 square miles, with over 69,000 households and a population of 178,200. The region includes 71,000 buildings with an estimated structural replacement value of $7,374 million (in 1994 dollars). An estimated 98% of the buildings and 78% of the building value is in residential housing.[44]

Consequences

While earthquakes can create widespread destruction and death, the damages experienced in southwest Virginia are more moderate, based on the historical record. It should be noted that earthquake analysis is tricky, given that the historical record covers a period of less than 175 years. A much better record for earthquakes would cover hundreds, even thousands, of years. The risk assessment in this report is based upon this limited range of data.

For the Mount Rogers region, the worst of the earthquakes experienced historically appear to correspond to an intensity of VI on the Modified Mercali Scale.[45] For purposes of analysis, we assumed an intensity of 6.3 and applied the HAZUS 99-SR2 computer model to reflect the characteristics of the Giles earthquake of May 1897.

At the 6.3 level magnitude, HAZUS predicted moderate damage to 3,902 buildings and slight damage to 7,423 buildings. Only 65 buildings would be completely wiped out. Other estimates by HAZUS[46] were as follows:

[43] Seismic hazards section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997.
[44] Data taken from HAZUS 99-SR2, which is based on 1990 U.S. Census data.
[45] From results of earthquake intensity database search with the National Geophysical Data Center.
[46] Please note, we were not able to apply HAZUS to other natural hazards considered for this report, since we lacked sufficient local data to feed into the computer model.

- $6.8 million damage to bridges, railways and airports.
- Minor injuries to 47 people, with 9 hospitalized and 1 dead.
- Economic losses of $118 million (or 1% of the total replacement value of the region's buildings).
- $3 million in damages to communication facilities.
- Significant loss of function in several schools, especially in Bland, Carroll and Wythe counties.

FLOODING

Description

Flooding is regarded as the most damaging natural hazard in Virginia. Average annual flood damages statewide amount to $100 million. Nationwide, between 1983 and 1997, Virginia ranked 14th with flood damages of $1,507 million.[47]

In the Mount Rogers region, flood damages can cost millions of dollars. In November 1977, flood damages to business and industry in Smyth County was estimated at up to $8.6 million. In the previous flood of April 1977, damages were estimated at $7.8 million for 16 jurisdictions.

More recently, in March 2002, Smyth County alone sustained an estimated $2 million in flood damages, compared to $100,000 in Wythe County and $360,000 in Washington County. Preliminary estimates from the November 2003 flooding came to $485,000 for Bland County, $251,000 for Carroll County and $878,000 for Smyth County.

Image No. 4: Flood-Related Definitions

Base Flood: Flood with a 1% chance of being equaled or exceeded in any given year. The Base Flood is the standard used by the National Flood Insurance Program.
Base Flood Elevation: The elevation of the water surface resulting from a flood that has a 1% chance of occurring in any given year.
Floodplains: Lowlands, adjacent to rivers, lakes and oceans, subject to recurring floods.
Floodway: The stream channel and that part of the adjacent floodplain that must remain open to permit passage of the Base Flood without raising the water surface elevation by more than one foot. Flooding is the most intense and poses the greatest risk in the floodway area.

Source: *Understanding Your Risks: Identifying Hazards And Estimating Losses* (FEMA how-to guide, August 2001).

Flood hazards in the local region include *riverine flooding* and the *flash floods* that result from sudden, violent storms that produce large amounts of rainfall in short amounts of time. *Riverine flooding* involves overflows from rivers and streams. The form of flooding is often more gradual in nature and may allow more time for advance warning. *Flash flooding* – such as occurred in November 2003, resulting in federal disaster declarations for several local communities – may occur with little warning and yet cause significant damage.

History

The Mount Rogers region of Virginia has a long history of flooding. The floods typically result from heavy rains or from melting following a severe winter storm. Heavy rains during thunderstorms can cause flash flooding in localized areas. As shown in Table No. 13, below, the region has experienced at least 16 presidential disaster declarations and at least three state-level emergency declarations from September 1972 through November 2003. This data only relates to major flood events and does not reflect the full range of flood events that have affected the region over the years.

[47] Hazards and Risk Section of Virginia Hazard Mitigation Plan, July 2001.

Table No. 13: Major Floods In The Mount Rogers Region

(Federal disaster declarations shown in shaded areas)

Date	Affected Localities	Description
11-18-03	Bland, Smyth, Galax; 12 counties and two cities in SW VA and NE TN	Heavy rains of 1.88" to more than 5" caused heavy flooding Nov. 18-19. Federal disaster declaration for Bland, Smyth, Galax in local region. $12 million damage across entire 12-county region.
2-15-03	Southwest Virginia (Wythe County declared a disaster)	State of emergency declared on 2-17-03 due to snow & ice in northwest VA and more than 4" of rain in southwest VA that caused flooding and mudslides. Federal disaster declared 4-28-03.
2-14-03	Washington, Bristol	Flooding from 4-day rainfall of 2-6" across southwest VA. See state of emergency declaration above.
4-17-02	Smyth, Washington, Wythe	Severe storms and flooding
3-17-02	Southwest Virginia	State of emergency declared on 3-18-02 due to heavy rainfall and flash flooding.
8-20-01	Washington	Severe storms and flooding
8-9-01	Smyth	Severe storms and flooding
7-26-01	Smyth, Washington	State of emergency declared on 7-29-01. This was part of the same weather pattern causing flooding on 7-8-01.
2-2-96	Bland, Grayson, Washington, Wythe	Flooding (resulting from Blizzard of 1996)
5-17-94	Galax	Severe ice storms and flooding
3-28-94	Bristol	Severe ice storms and flooding
3-10-94	Bland, Carroll, Grayson, Smyth, Washington, Wythe	Severe ice storms and flooding
5-19-92	Carroll	Severe storms and flooding
5-29-84	Washington	Severe storms and flooding
5-07-84	Town of Damascus	Flooding on Beaverdam Creek. Town declared a federal disaster area for damage to sewer system, Virginia Creeper Trail and private homes.
11-17-77	Carroll	Severe storms and flooding
11-12-77	Grayson, Smyth, Washington	Severe storms and flooding
10-02-77	Bristol	This 20-year flood caused $3 million in damage in 1977 dollars.
4-21-77	Carroll	Severe storms and flooding
4-7-77	Bland, Grayson, Smyth, Washington, Wythe	Severe storms and flooding
9-8-72	Smyth, Galax	Tropical Storm Agnes (flooding)
March 1867	Bristol	Flood of record for Beaver Creek in Bristol, TN and Bristol, VA. This was a 250-year flood.

Source: Virginia Department of Emergency Management, National Climatic Data Center, news accounts, U.S. Army Corps of Engineers flood study of Bristol, VA and Bristol, TN, also report called "Damascus Flood Damage Reduction Project," cited elsewhere in this document.

For Bristol the flood of record occurred in March 1867. This 250-year flood on Beaver Creek and its tributaries caused $1 million worth of damages (in 1867 dollars). More recently, in October 1977, a 20-year flood caused $3 million worth of damages (in 1977 dollars) on the Bristol, Virginia side alone. The worst and most costly of flood damages on an annual basis occurs along the main stem of Beaver Creek.[48]

[48] From the Bristol, VA-TN "Detailed Project Report: Flood Damage Reduction Feasibility Study," draft copy, U.S. Army Corps of Engineers. July 2003.

For the Mount Rogers region as a whole, the worst flooding within the past 50 years occurred in April[49] and November of 1977. The floods of 1977 later led to engineering reports that encouraged people to move out of the floodplain. More details on the 1977 floods appear in Table No. 14, below.

Table No. 14: More Details on the 1977 Floods
Mount Rogers Region, Virginia

Date & Localities Affected	Details
November 1977 8 SW VA localities, including Smyth County	$8.6 million worth of damages to business and industry in Smyth County, including industries in Atkins, Marion, and Chilhowie. High water measured at 3.5' in Mouldings Inc. (now Royal Mouldings) near Atkins, 1.7' above first floor of First Baptist Church in Chilhowie, 3.25' above floor in guardhouse at Brunswick Corporation (now General Dynamics) in Marion, 2' above floor at Curry Manufacturing (now Visador Co.) in Marion. Flooding occurred along the Middle Fork Holston River and two tributaries (Carlock Creek in Chilhowie and Staley Creek in Marion). Flooding exceeded what would be expected for a 100-year flood event. $1.5 million damage to 60 homes in Chilhowie.
April 1977 Smyth County Washington County 14 other localities	Resulted from two fast-moving rainstorms, dropping 5-6" in Mount Rogers region and up to 15" near W VA line. More than $100 million in damages to entire SW VA region. In **Chilhowie**, 200 people evacuated from their homes and there was damage to numerous businesses. In **Damascus**, 50 people evacuated from Beaverdam Creek area and at least one local industry sustained damage. The flooding damaged roads and water and sewer treatment plants. Flooding occurred along the Middle Fork Holston River (towns of Marion and Chilhowie, communities of Atkins and Seven Mile Ford), the South Fork Holston River (Sugar Grove community in Smyth County), and North Fork Holston River (town of Saltville and communities of McCready and Mendota). $500,000 damage to 50 homes in Chilhowie.

Sources:
"Flood of April 1977 in the Tennessee River Basin," Flood Report WM-27-5-1, by Division of Water Management of the Tennessee Valley Authority. March 1978.
"Middle Fork Holston River Flood Control Improvements Study," by Dewberry, Nealon & Davis. March 1978.
"Chilhowie Flood Relocation Project Report," by Mount Rogers PDC. June 1986.

Engineering Studies

An engineering study in 1978 on flooding in Smyth County eventually led to a special project in Chilhowie[50] that relocated 67 families and created the Chilhowie Recreation Park. Building on flood study work begun by the Tennessee Valley Authority in the late 1950s, the Town of Damascus[51] also undertook projects to relocate 34 homes (88 residents) and three businesses out of the floodplain following the 1977 flooding.

[49] The April 1977 flooding led to special reports by the state Water Control Board, the state Office of Emergency Services and the Tennessee Valley Authority.
[50] "Chilhowie Flood Relocation Project Report", Mount Rogers Planning District Commission, June 1986.
[51] Damascus Flood Damage Reduction Project, by Carl I. Rasnic, October 1988.

The Middle Fork Holston River Flood Control Improvements Study, completed in March 1978, studied flooding issues in Smyth County, with special focus on the Town of Chilhowie/Seven Mile Ford community and the Town of Marion/Atkins community.

Initial recommendations from that 1978 study[52] carried a total implementation cost of $18 million. Later the study was reduced to three sub-projects, but the price tag still proved very high. The recommendations included channelizing parts of the Middle Fork Holston River, with rip rap or concrete reinforcement, flood-proofing for selected businesses and industries, rebuilding several bridges to accommodate the widened river channel, relocations out of the floodplain, and installing some levees and pump stations. Of all the proposals discussed in the 1978 study, channelizing the river was deemed as a top priority with the potential for making the greatest impact on future flood levels. See cost details in Table No. 15.

Table No. 15
Proposed Mitigation Costs (1978)
Smyth County Communities

Locality or Project	1978 Estimate	2004 Estimate[53]
Town of Chilhowie	$3972,000	$7,070,160
Town of Marion	$4,480,000	$7,974,400
Atkins community	$2,306,000	$4,104,680
Detention reservoirs	$1,362,000	$2,424,360
Total:	**$12,120,000**	**$21,573,600**

The recommendations also included removing obstructions from the Middle Fork (including the breached dam at the old Marion Ice Plant), development of six flood storage reservoirs along six tributaries, and implementation of floodplain ordinances to limit future development in the floodplain area.

Although the 1977 floods had serious impacts for several industries located in the Middle Fork Holston floodplain, the industries declined to implement the recommendations due to the high cost. The local communities felt equally intimidated by the proposed mitigation costs, and there was little hope of major help from among a range of federal agencies to provide the 100% grant funding needed to carry out any of the proposed projects.[54] The Planning District Commission finally decided to try to get the most for the funds available by demolishing the most flood-prone structures in Chilhowie and relocating families out of the floodplain.

The project that eventually emerged was a $2.8 million multi-part proposal to relocate families out of the Middle Fork Holston floodplain in Chilhowie, build replacement housing in a new subdivision created for the relocation, and to provide water treatment improvements for the town of Chilhowie. The project area included 72 homes, three churches, three businesses and one lodge. To succeed at all, the effort had to overcome numerous complications created by the funding agencies, the attitudes of local residents, and the feelings of the town council, which observers felt cared more about the water treatment project than the flood mitigation project.[55]

[52] From page 3 of the "Middle Fork Holston River Flood Control Improvements Study." March 1978.
[53] Cost estimated based on 3% increase over 26 years, an increase of 78%.
[54] As described by the "Chilhowie Flood Relocation Report," op.cit.
[55] Ibid.

In the end, 67 families moved out of the floodplain. Of those, 53 families had help from the Tennessee Valley Authority and 14 had help through the Department of Housing and Urban Development. Due to the time it took to form the Chilhowie Redevelopment and Housing Authority (created in July 1979) and the new subdivision, most families relocated elsewhere. Only six families opted to relocate to the subdivision as planned. The town had the abandoned property demolished and built a community recreation park in the floodplain area (between Holston Street and Railroad Avenue). The project took seven years to complete.

Historically a flood-prone community due to development along Beaverdam and Laurel Creeks, along with obstructions in the creeks, Damascus suffered three major floods in 1977 (in April, October, and November). Twice in 1977[56] the community qualified as a federal disaster area. The 1977 flood events 1977 led to a comprehensive flood mitigation study completed in 1979.[57] An initial cost estimate of more than $3.2 million would have built a levee emergency access route, relocated flood-prone homes out of the floodplain, flood-proofed some homes and businesses, removed two abandoned dams from Laurel Creek, installed storm drainage collection systems, and required more control of floodplain development by the town. In 1981, a follow-up flood mitigation program proposed by the town was estimated at $4.3 million.

Image No. 5: Flooding in Damascus, VA

Bristol Herald Courier image of flooding in Damascus in November 2003.

Successful efforts by Damascus to mitigate its flooding problems over the years have included the following:

- A $559,000 grant from the HUD in 1981 to install storm sewers along Mock, Surber, and Haney Hollows (finished in 1983).
- State and federal disaster assistance following another major flood in May 1984 helped make repairs to nearly $86,000 worth of damage to the community.
- Grant funding in 1984 ($700,000 from the state CDBG program and $190,000 from the Tennessee Valley Authority) to relocate 34 families (88 people) and three local businesses[58] out of the floodplain (1985 through 1988).
- The town also converted the old Damascus Elementary School for housing under a project funded by the state CDBG program.

[56] The 1977 floods had been more serious than past floods due to increased floodplain development since the 1940s and the tendency of major parts of the small town to get cut off from access to emergency help due to high waters and flooded streets.

[57] As re-counted in the "Damascus Flood Damage Reduction Project," by Carl I. Rasnic. October 1988.

[58] Other parts of the original plan - to remove an old dam from Laurel Creek, clear Legion Island, and flood-proof some structures – were taken out due to agency opposition and lack of funds.

Recent Flood Events

The more recent flood events from 2001-2003 were less drastic in extent and damages compared to the floods of 1977. Nonetheless the floods disrupted the lives of those who had to endure them, including the first major flood in several decades for the City of Galax.

Image No. 6: Flooding in Marion, VA

View of flooding at Baughman Street Bridge in Marion. The bridge itself becomes a barrier during times of high water.

The events of 2001 occurred in late July and early August. Heavy rainstorms caused flooding that forced more than 100 Smyth County residents from their homes, according to news accounts. Smyth and Washington counties became federal disaster areas. In all the flooding affected nine counties in southwest Virginia and led to at least $4.4 million in state and federal aid.

The next round of disaster-level flooding occurred March 17-20, 2002. Three to six inches of rain fell in a 36-hour period and led to federal disaster declarations for Smyth, Washington and Wythe counties.

The event affected numerous homes and businesses, with residential evacuations along the North Fork Holston River in Smyth County and in a remote part of Washington County. The floods also created overflows for water and sewer plants in the three counties, ruined some businesses and temporarily stranded some communities, such as downtown Chilhowie. FEMA disaster aid came to more than $500,000 in the local region as of June 2002, with an estimated $2.5 million total in damages. For the entire southwest Virginia region state and federal disaster assistance had reached $8 million.

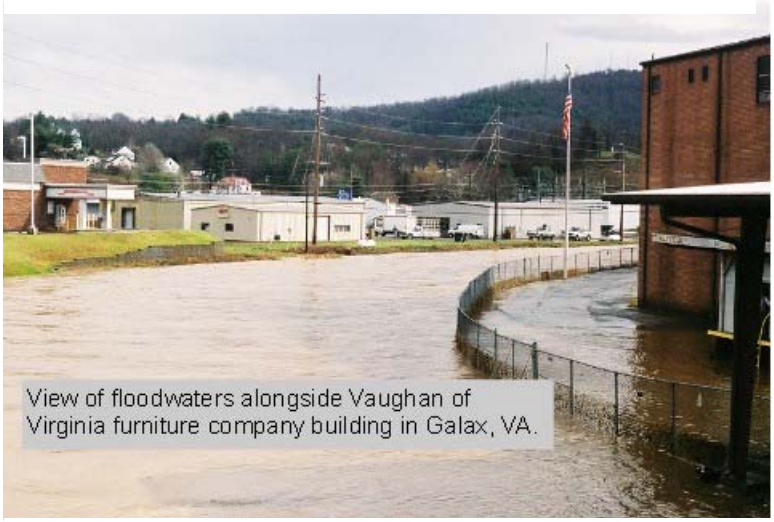
The 2002 flooding led Chilhowie to undergo a preliminary $100,000 study by the U.S. Army Corps of Engineers on causes of the flooding and potential solutions, including river dredging and use of levees. In March 2004, the town manager recommended buy-outs of the 15 properties that flood most often.[59] In Smyth County a decision was made to offer the buy-out option to six homeowners located on River Bottom Circle along the North Fork Holston River.

The flood disasters continued into 2003, with a federal declaration resulting from two back-to-back snowstorms February 15-28, affecting 10 southwest Virginia counties. In total the storm cost $37 million in snow removal costs and $71 million in damages to homes, businesses, public facilities, roads and other property.[60] In the local region, Bland and Wythe counties sought federal aid for flood damages to public and private property.

[59] News story, March 17, 2004, Smyth County News & Messenger.
[60] News release, Gov. Mark Warner's office, Feb. 28, 2003.

On November 18-19, 2003, heavy rains caused severe flooding across 10 counties in northeast Tennessee and southwest Virginia. In Bland County damages were estimated at $485,000, with $878,000 in damage in Smyth County and $251,000 in damage in Carroll County. This included major damage or destruction of numerous homes, numerous flooded roadways, damage to public and private property, some evacuations and temporary closure of area schools.

Image No. 7: Flooding in Galax, VA



MRPDC image of disaster-level flooding in the City of Galax in November 2003.

The City of Galax suffered its first major flooding since 1940; initial reports to FEMA included damage to 10 businesses and 70 homes in an area that included the city's main business district along Chestnut Creek. Some sinkholes appeared, and there was flooding in several nearby residential communities. Total damages amounted to $100,000, with about half consumed by the cost of cleanup by the city, according to city officials. Because Galax does not participate in the National Flood Insurance Program, the designated floodplain area was not eligible for federal disaster assistance. The city so far has resisted suggestions it consider re-joining the flood insurance program. Damaged properties located out of the designated floodplain were eligible for disaster assistance. City officials have said many flooding problems are caused by undersized and deteriorated stormwater drainage systems.

National Flood Insurance Program

Most communities with flooding issues in the local region participate in the National Flood Insurance program (NFIP). Participation in NFIP allows homeowners and commercial businesses to obtain flood damage protection. For single-family homes, the insurance provides up to $250,000 for structural damages and up to $100,000 for contents damages. Commercial businesses can be covered for up to $500,000 in structural damages and up to $500,000 in contents damages.

Flood insurance helps cover flood damages during minor and major flood events. Insurance coverage through NFIP also covers a larger amount for losses than typically would be available during a federal disaster. Emergency aid that is available following declaration of a federal disaster most often comes in the form of a low-interest loan.[61] FEMA promotes participation in NFIP for all qualifying communities.

[61] For more information, see the Flood Insurance section of the FEMA website at www.fema.gov/nfip.

Table No. 16: Community Participation in NFIP
Mount Rogers Region, Virginia

Jurisdiction	NFIP Status			
	Y	N	N/A	CRS Class
Bland County	X			na
Carroll County	X			na
Grayson County	X			na
Smyth County	X			na
Washington County	X			na
Wythe County	X			na
City of Bristol	X			na
City of Galax		X		na
Town of Abingdon	X			na
Town of Chilhowie	X			na
Town of Damascus	X			na
Town of Fries		X		na
Town of Glade Spring	X			na
Town of Hillsville		X		na
Town of Independence	X			na
Town of Marion	X			na
Town of Rural Retreat			X	na
Town of Saltville	X			na
Town of Troutdale			X	na
Town of Wytheville	X			na

Note: Localities marked as N/A lack recognized floodplains, so technically they are not eligible to participate in NFIP.

Matrix on NFIP Status of Local Jurisdictions

As shown in Table No. 16, most of the localities participate in floodplain management and make NFIP coverage available to property owners. The City of Galax, with Chestnut Creek flowing through the city's downtown industrial district, participated in NFIP for a few years before dropping out. As a result of the November 2003 flood disaster, the city met with state and federal flood program officials. The city has opted to remain a non-participant.[62]

While NFIP has its weaknesses, FEMA officials continue to regard the program as one of the most effective measures in the nation to promote floodplain management and reduce at least some flooding damage. While NFIP has not prevented continued encroachment on the flood fringe, thereby creating further constraints on the floodplains, the long-standing federal program has at least succeeded in forcing communities to address floodplain issues. That is better, in the federal view, than no floodplain management at all.[63]

[62] Virginia state flood program officials view the City of Galax as a special case. The state has acknowledged that city officials have defensible reasons for opting out of participation in NFIP.
[63] From presentation by Errol Garren, of FEMA's Mitigation Division, during the June 2004 Hazard Mitigation Summit sponsored by the Virginia Department of Emergency Management in cooperation with the University of Virginia at Charlottesville.

One major drawback for the floodplain maps in effect for the Mount Rogers region, as well as for many communities nationwide, is the age and relative inaccuracy of the maps. Many of the existing maps in the local region date back to the 1980s, and some bate back to the 1970s.

In addition, most local floodplains have not been subject to hydrological studies to determine the Base Flood Elevations; the floodplain extent in such cases have been estimated based on the local topography (see Map No. 3A in the appendices).

Table No. 17: NFIP: Policy Statistics
Mount Rogers Region, Virginia
(Data as of Sept. 30, 2003)

Community	Policies in-force	Insurance in-force (whole $)	Written premiums in-force
Abingdon	17	$1,585,600	$5,638
Bland County*	57	$3,543,900	$24,555
Bristol City	61	$10,981,200	$60,847
Carroll County*	18	$2,044,900	$6,888
Chilhowie	16	$2,107,500	$9,481
Damascus	23	$1,908,900	$12,363
Fries	0	0	0
Galax City	0	0	0
Glade Spring	3	$122,600	$1,134
Grayson County*	17	$1,938,800	$16,293
Hillsville	0	0	0
Independence	2	$248,000	$482
Marion	43	$3,110,600	$19,684
Rural Retreat	0	0	0
Saltville	8	$919,400	$4,627
Smyth County*	111	$20,814,200	$118,005
Troutdale	0	0	0
Washington County*	46	$4,773,700	$22,658
Wythe County*	36	$2,446,700	$12,893
Wytheville	5	$676,600	$2,510
Mt Rogers Region	463	$57,222,600	$318,058

* Refers to unincorporated sections of county.
Source: Policy statistics section at www.fema.gov/nfip.

As shown previously, most communities in the Mount Rogers region participate in NFIP.

Table No. 17, at left, gives further details, by locality, on how many flood insurance policies are in-force, the value of insurance coverage, and the value of the written premiums for the insurance policies, as of Sept. 30, 2003, as provided by FEMA.

The largest number of NFIP-supported insurance policies (111) are in Smyth County. When the three local towns are included – Chilhowie, Marion, and Saltville – the total for the Smyth County community rises to 178. This amounts to approximately one-third of all NFIP policies in effect for the entire Mount Rogers region.

As shown in Table No. 18, below, Smyth County has received a relatively large share of payments under the National Flood Insurance Program, due to the frequency and severity of flooding in that county.

Table No. 18: Loss Statistics Under NFIP
Mount Rogers Region, Virginia
Jan. 1, 1978 through Dec. 31, 2002

Locality	Total Losses	Closed Losses	Open Losses	CWOP Losses	Total Payments	Percent of Total Payments
Abingdon	11	10	0	1	$158,110	8%
Bland County	25	18	0	7	$193,398	10%
Bristol	10	8	0	2	$33,143	--
Carroll County	8	7	0	1	$79,156	--
Chilhowie	30	23	0	7	$134,599	7%
Damascus	10	4	0	6	$6,311	--
Galax*	2	2	0	0	$3,227	--
Glade Spring	1	1	0	0	$4,347	--
Grayson County	5	3	0	2	$14,563	--
Marion	32	21	0	11	$192,958	10%
Saltville	1	1	0	0	$1,271	--
Smyth County	64	43	0	21	$684,422	36%
Washington County	32	24	0	8	$293,830	16%
Wythe County	10	7	0	3	$48,165	--
Wytheville	1	1	0	0	$35,472	--
Mt. Rogers Region	**242**	**173**	**0**	**69**	**$1,882,971**	

Source: NFIP Policy and Claim Statistics found at www.fema.gov/nfip/pcstat.shtm under Claim Information by State.
Notes:
Total Losses are all losses submitted regardless of status; Closed Losses have been paid, Open Losses have not been paid in full; CWOP losses have been closed without payment; Total Payment means total amount paid on losses.
* The City of Galax has not participated in NFIP for many years.

Risk Assessment

Probability and Frequency

The Mount Rogers region has experienced 18 presidential disaster declarations or state-level emergencies related to flooding over 30 years. That does not account for the more minor flooding that may occur from time-to-time due to a brief but severe rainstorm or thunderstorm causing small stream flooding in localized areas.

The FEMA floodplain maps available for communities participating in the National Flood Insurance Program (NFIP) depict 100-year floodplains for flood-prone areas. That means, in any given year, the floodplain area faces a 1% chance of having a flood.

Repetitive loss properties are those that have received federal aid more than once due to a flood disaster. Of the 18 such properties in the local region, none have received mitigation work to reduce flood damage and only 11 carry NFIP insurance, as shown in Table No. 19, below.

Table No. 19: Repetitive Loss Properties due to Flooding
Mount Rogers Region, Virginia
As of Dec. 31, 2003

Local Jurisdiction	Mitigated?	Insured?	Community	Occupancy**	Total Building Payments	Total Contents Payments	Losses	Total Paid	Average Payment	Building Value
ABINGDON	N	N	ABINGDON	SF	$69,559	$28,540	2	$98,099	$49,050	$164,840
BLAND COUNTY *	N	N	ROCKY GAP	SF	$23,405	$7,506	2	$30,910	$15,455	$65,600
BLAND COUNTY *	N	Y	ROCKY GAP	SF	$12,491	$0	3	$12,491	$4,164	$76,528
BLAND COUNTY *	N	N	-	SF	$91,309	$0	2	$91,309	$45,655	$185,000
BLAND COUNTY *	N	Y	ROCKY GAP	SF	$47,009	$12,787	3	$59,795	$19,932	$205,179
BLAND COUNTY *	N	Y	BLAND CO	SF	$12,366	$4,543	5	$16,909	$3,382	$63,776
CARROLL COUNTY *	N	N	HILLSVILLE	OR	$31,939	$0	2	$31,939	$15,970	$68,000
CHILHOWIE	N	N	CHILHOWIE	NR	$0	$6,406	3	$6,406	$2,135	NA
CHILHOWIE	N	Y	CHILHOWIE	NR	$20,649	$1,320	2	$21,969	$10,984	$63,115
CHILHOWIE	N	Y	CHILHOWIE	SF	$4,176	$0	2	$4,176	$2,088	$61,243
SMYTH COUNTY *	N	Y	CHILHOWIE	SF	$30,917	$0	2	$30,917	$15,459	$48,132
SMYTH COUNTY *	N	Y	CHILHOWIE	SF	$6,883	$0	2	$6,883	$3,441	$105,840
SMYTH COUNTY *	N	Y	MARION	SF	$6,800	$3,711	2	$10,511	$5,255	$73,269
SMYTH COUNTY *	N	Y	SALTVILLE	SF	$13,042	$12,284	2	$25,326	$12,663	$102,500
SMYTH COUNTY *	N	Y	SALTVILLE	SF	$12,410	$7,968	2	$20,377	$10,189	$67,424
WASH. COUNTY*	N	Y	MENDOTA	SF	$35,943	$26,258	2	$62,201	$31,100	$87,768
WASH. COUNTY*	N	N	BRISTOL	NR	$12,729	$5,182	3	$17,911	$5,970	$228,000
WYTHE COUNTY *	N	N	MAX MEADOWS	SF	$11,623	$3,093	2	$14,716	$7,358	$151,100

Source: Virginia Department of Emergency Management.
** NA means not available. SF means single-family. NR means non-resident. OR means other-resident.

Exposure

The following Table No. 20, shown below, gives our estimate of total property values, by category (class of property) and by locality. While we have no way of knowing how much damage any given flood might cause, we can make some rough estimates based on repetitive loss payments shown above in Table No. 19.

The average payment for damages on 18 repetitive loss properties comes to $14,458. The average building value for the 18 properties comes to $100,962. That means repetitive loss properties have incurred payments, on average, of roughly 14% of the total building value. Based on that experience and limited database, we can assume that the average disastrous flood might result in damage payments equaling 14% of property value.

Table No. 20: Estimated Property Values in Flood-Prone Parts of Mount Rogers Region
By Locality and Class of Property

Locality	Class of Property	Number in Class	Total Estimated Property Values
Bland County	-	-	-
(including communities of	Resid.	63 homes	**$3,074,652**
Bland, Bastian, Rocky Gap,	Resid.	25 mobile homes	**NA**
and Wolf Creek)	-	-	-
Carroll County	Resid.	20 homes	**$976,080**
Town of Hillsville		no identified floodplain	**NA**
Grayson County	Resid.	10 homes	**$488,040**
Town of Fries	-	limited floodplain development	-
Town of Independence	-	limited floodplain development	-
Town of Troutdale	-	no identified floodplain	-
Smyth County	-	-	-
(including towns of Chilhowie,	Resid.	484 homes	**$18,723,531**
Marion, Saltville and Allison's Gap area,	Resid.	46 mobile homes	**NA**
Atkins, Broadford, and Sugar Grove)	Comm.	66 businesses	**$12,883,302**
	Industry	11 structures	**$10,713,600**
	Govmnt	13 structures	**$20,210,301**
	Non-Profit	23 structures	**$2,845,959**
Washington County	-	-	-
(including towns of Abingdon,	Resid.	194 homes or townhouses	**$14,847,732**
Damascus, and Glade Spring)	Comm.	32 businesses	**$7,637,908**
-	Industry	1 structure	**$98,100**
-	Govmnt	11 structures	**$2,494,300**
-	Non-Profit	8 structures	**$3,181,300**
-	Other	1 structure	**$367,200**
Wythe County	-	-	-
Town of Rural Retreat	-	8 homes	**$470,000**
-	-	-	-
(including Town of Wytheville	Resid.	73 homes	**$3,562,692**
and Max Meadows community)	Comm.	31 businesses	**$9,157,059**
-	Industry	-	-
-	Govmt	9 structures	**$8,141,112**
-	Non-Profit	2 structures	**$446,194**
City of Bristol		We did not attempt to do separate estimates because this would only duplicate the work of the U.S. Army Corps of Engineers. Both Bristols, in Virginia and Tennessee, have made commitments to structural improvements designed to reduce flood impacts.	Most of the mitigations are recommended in Bristol, TN along Beaver Creek. The USACE calculated expected annual flooding damages at $3.9 million along Beaver Creek
City of Galax	-		
(near Chestnut Creek or Mill Creek)	Resid.	55 homes	**$2,684,220**
(near Mill Creek – no floodplain)	Resid.	151 mobile homes	**NA**
(in floodplain – Chestnut Creek)	Industry	15 structures (flood-proofed)	**NA**

Notes: See added details in Table A in appendices section.

Consequences

Flooding causes damages ranging from blocked roadways and flooded basements to severe damage and destruction of homes and businesses. People sometimes die when they attempt to cross flood-swollen creeks that under normal circumstances appear fairly harmless. Severe flooding can take out bridges and sections of roadway. Flooding can also force people out of their homes into emergency shelters as a way to save lives and prevent people in flood-prone areas from becoming stranded. Fortunately, despite the constant threat of flooding for much of the Mount Rogers region, few people have died. Many more have sustained property damage, and some have been relocated out of the floodplain through government-sponsored programs.

Image No. 8: Neighborhood Flooding in Galax, Virginia in November 2003.

Residential neighborhoods in Galax get flooded in part due to the city's deteriorating storm drain system. Collapses in the piping causes blockages that re-direct storm water and create flooding problems, especially along tributaries to Chestnut Creek, according to city officials.

Image No. 9: Flooding over Dam at old Marion Ice Plant.

This dam, located on the Middle Fork Holston River, is breached at the far end. During bad floods, the water volumes in the river get so high the water goes right over the dam. Image by MRPDC.

KARST and SINKHOLES

Description

Karst and sinkholes are features in the landscape usually associated with carbonate rock (limestone, dolomite, gypsum) that has been dissolved over millions of years by groundwater. This process leads to creation of underground cracks, fissures and caves that can serve as a direct route of transport of surface pollutants into the groundwater system. Karst features in Virginia also are associated with exceptionally rare plant and animal habitats, some found nowhere else in the world.

Sinkholes can appear when the underground system has become weakened through withdrawal of groundwater, mining activities, wetlands drainage, or as a result of the continued dissolution of the underlying rock deposits. Sinkholes may appear as depressions in the landscape or as open holes.

The appearance of sinkholes and subsidence of the landscape can occur gradually and broadly, as is often typical with the drainage of wetlands. Subsidence also can happen abruptly with the sudden formation of localized sinkholes; this occurs most often in abandoned mines, but also is known to occur along highways such as Interstate 81. At times subsidence happens on a more massive scale, with creation of holes large enough to swallow a house or other surface structures.

The Valley and Ridge geologic province includes a system of aquifers that contain carbonate rock (karst) and undifferentiated sedimentary rock. This is a particular problem for Bland, Wythe, Smyth and Washington counties. The Virginia Speleogical Survey has accounted for at least 562 caves among the four counties. Karst terrain, which includes more than just caves, is a factor in 20% of Bland County, 30% of Smyth and Wythe counties and 50% of Washington County.

Sinkholes are of particular concern because they serve as conduits between surface water and groundwater. This interaction can lead to rapid transport of surface pollutants introduced by various means such as urban runoff and use of sinkholes as trash dumps. The underground drainage system can also be blocked by erosion and sedimentation from construction sites and other human activities. Because so many people rely on groundwater (and wells) for drinking water, it is critical to protect the purity of groundwater, especially in the environmentally sensitive karst terrain.

History

In the local region, sinkholes suddenly appear from time to time on Interstate 81, which passes through the karst region of Virginia. One recent incident occurred in October 2003, when a sinkhole appeared on I-81 about one mile past the junction with I-77 in Wythe County.[64] Both the Virginia Department of Transportation and Duke Energy said the sinkhole appeared in connection with drilling under the highway in connection with installation of a 24-inch natural

[64] News account, Wytheville Enterprise, Oct. 18, 2003.

gas pipeline. The incident blocked a northbound lane of I-81 for a few days before VDOT completed the needed repairs and the reopened the lane to regular use (see Table No. 21, below).

Subsidence also has been a problem for Saltville due to mining for salt and gypsum.[65] Salt mining first began in 1782 and continued until 1972 with the shutdown of Olin Industries, once a major employer in Saltville. Commercial production of salt resumed in 2000 with completion of an evaporator plant by Virginia Gas Company, which was removing brine from the underground caverns to make room for natural gas storage.

Gypsum mining began in 1815 and continued under the U.S. Gypsum Company, starting in the early 1900s. U.S. Gypsum, which has since moved to production of artificial gypsum, closed its Saltville area facilities in 2000.

Table No. 21
Subsidence Incidents in Saltville, Virginia

Year	Description
Mid-1940s*	Closure of North Holston gypsum mine after the North Fork Holston River broke into the mine, located just north of Saltville.
1960	Major collapse and sinkhole development around Wells 1-4 in the high-pressure brine field between Saltville and the Plasterco community. Collapse created crater 400 feet across and 250 feet deep.
1977	Collapse of section of State Rt. 91 into a sinkhole 50 feet in diameter in front of U.S. Gypsum Company offices in Plasterco community.

Source: Narrative in 2001 certificate of need application by Saltville Gas Storage Co., L.L.C., to the Virginia State Corporation Commission.
* Various sources cite this incident as occurring in 1946, 1947 or 1948.

In 1960 a major collapse occurred in a section of the high-pressure brine field located just southwest of Saltville. The collapse involved four wells spaced closely together and considered shallow, ranging from 450 to 800 feet deep, according to expert testimony.[66] Over time the bottom cavities of the wells appeared to have merged together. The underground collapse moved upwards through the relatively thin rock "roof" layers (themselves 200-316 feet thick) to the surface. This resulted in a crater 400 feet wide and 250 feet deep.

More recently, a section of State Rt. 91 collapsed into a 50-foot wide sinkhole in front of the offices of U.S. Gypsum. In the past gypsum mining had occurred under the collapse site and may have been a contributing factor. Blame was also placed on a leaking water line that had apparently dissolved the underlying limestone, thereby weakening the underground support structure and leading to the collapse. It should be noted these incidents have resulted from human-induced activities, while the focus of this study has been on hazards created by nature.

In the Wythe County community of Ivanhoe an underlying sinkhole eventually caused the floor of the local post office to fall through. A new post office has since been established for Ivanhoe.

[65] See certificate of need application (November 2001) by Saltville Gas Storage Company, L.L.C. to the Virginia State Corporation Commission for development of a major underground natural gas storage facility in the old salt caverns of Saltville. See especially Vol. 1 (Exhibit 14 and Schedule E) and Vol. 2 (Resources Report No. 6.0: Geologic Resources and Hazards).
[66] Ibid.

Karst terrain also is a factor in the Town of Chilhowie, which is investigating why the town water system loses 16 million gallons a month; some is thought to leak into the underlying terrain. Construction workers for Duke Energy Gas Transmission also encountered karst terrain during the recent installation of the Patriot Extension natural gas pipeline near New River Trail State Park (near Foster Falls in Wythe County).

Risk Assessment

Probability and Frequency

There is no known way to predict when sinkholes might open up or when subsidence might occur. There is only limited data available on karst terrain, its extent, and its importance from an ecological standpoint and as a natural hazard.

The ecological importance of this landform is only beginning to be understood through the efforts of various state and federal agencies and by groups such as the Karst Waters Institute, Cave Conservancy of the Virginias, The Nature Conservancy, and others.

As noted in the section on landslides, detailed basic geology maps are still under development in the state and local region. It is not possible to make any risk assessment other than in a generalized fashion. This task may become possible in the future under a new program on karst and subsidence hazards proposed for the National Cooperative Geologic Mapping Program. The NCGMP is a digitized mapping effort by the U.S. Geological Survey in coordination with the Association of American State Geologists. The Geologic Mapping Act of 1992 mandated creation of a national geologic database.

The Karst and Subsidence Hazards[67] program has been planned to develop better understanding of groundwater contamination, sinkhole formation, new techniques for karst analysis through remote sensing and geophysics, regional karst issues in the Appalachians, and understanding of karst issues on a national scale through development of a new National Atlas karst map.

Exposure

Karst terrain is a special concern for Bland, Wythe, Smyth and Washington counties as a feature of the Valley and Ridge geological province.

Consequences

Karst as a natural hazard can be a costly matter for the community. There are the long-term costs associated with environmental pollution and contamination of the groundwater supply. There also are costs associated with damage created by subsidence, such as the collapse of State Rt. 91 into a sinkhole near Saltville in 1977. In 2004 VDOT was nearing completion on relocating 0.5 miles of Rt. 91 at an estimated cost of $2 million.

[67] See description contained in "Geologic Aspects of Karst in the Appalachians," by Orndorff, Epstein, Weary and Harlow and found at www-va.usgs.gov/GLOBAL/Abst/Harlow_karst.htm.

Due to the lack of mapping of significant karst terrain, incidents involving the sudden appearance of sinkholes and leakage often come as a surprise to local governments.

A more detailed and comprehensive assessment of costs associated with karst hazards in the Mount Rogers region is not possible based on available data.

Image No. 10: Tree in a Sinkhole.

This tree stands in a sinkhole along State Rt. 16 in Marion, VA. Sinkholes often appear as depressions in the landscape and can be covered over with earth and vegetation, as shown here. Other sinkholes appear as holes or cave openings. Image by MRPDC.

LANDSLIDES

Description

Landslides can be defined as the downward and outward movement of soils and slope-forming materials reacting under the force of gravity.[68] These movements can be triggered by floods, earthquakes, volcanic eruptions and excessive rain. The three important natural factors include topography, geology and precipitation. Human-caused factors include cut-and-fill highway construction, mining and construction of buildings and railroads.

Types of landslides include slides, flows, falls and topples (which occur rapidly), and lateral spreads (which occur much more slowly).

The Appalachian Highlands, along with other mountainous regions of the United States, are known to be highly susceptible to landslides. These come in the form of earth flows, debris flows and debris avalanches, mainly in areas of weathered bedrock and colluvium. Debris avalanches can occur during period of continual steady rainfall followed by a sudden heavy downpour.[69] Areas prone to landslides include the plateau of the western Appalachian Highlands (especially in Tennessee and Kentucky) and southeast of the Appalachian Plateau, in the flanks of the Appalachian Ridge and the Blue Ridge (which includes the Mount Rogers region). For the most part these movements are comprised of slowly moving debris slides.

On a generalized scale, hazard-prone areas have been mapped by the U.S. Geological Survey. However, this information needs to be evaluated at ground level to more clearly identify the landslide-prone areas of the Mount Rogers region.

History

Information is limited regarding landslides and debris flows for the Mount Rogers region. While generalized statewide geology maps have been published, detailed maps for the local region are still in development. These will become the basic geology maps that in the future can be used in landslide risk assessment. Geologists with the Virginia Department of Mines, Minerals and Energy were in the process in 2003 of creating basic geology maps in Washington County and were planning to move into Smyth County and other parts of the Interstate 81 corridor. In the past most geologic mapping related to resources of economic value, such as coal.

The record is scant concerning landslide incidents in the Mount Rogers region. A staff review of a comprehensive, nationwide database[70] giving locations of debris flows, debris avalanches, and mud flows revealed no information pertaining to the local region.

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[68] Geologic hazards section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997.
[69] "Landslide Overview Map of the Conterminous United States," Geological Survey Professional Paper 1183 (1983).
[70] "Map Showing Inventory and Regional Susceptibility for Holocene Debris Flows and Related Fast-Moving Landslides in the Conterminous United States," by Earl E. Brabb, Joseph P. Colgan and Timothy C. Best, U.S. Geological Survey, at http://geopubs.wr.usgs.gov/map-mf/mf2329.

Events that do appear in the literature include a major landslide in Madison County during the summer of 1995, debris flows and flooding in the Potomac and Cheat River basins in 1985, and debris flows created by Hurricane Camille in Nelson County in 1969.[71] The Madison County event resulted from an intense June rainstorm that caused hundreds of debris flows and later led to a federal disaster declaration, with damages estimated at more than $100 million.

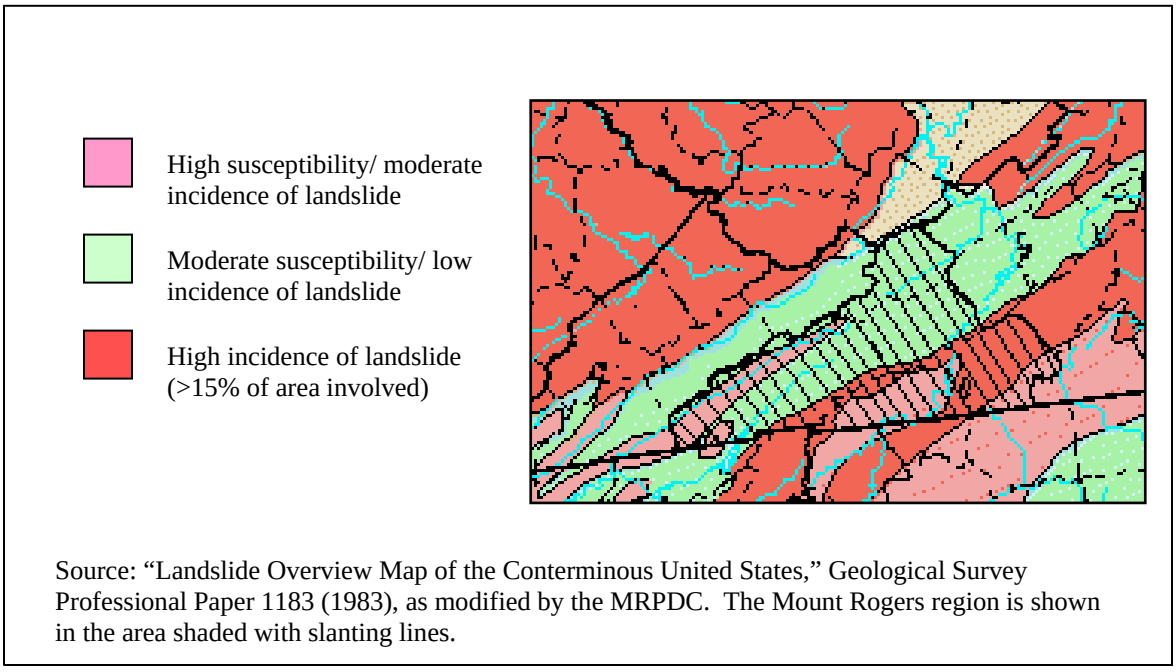
Three days' worth of rainstorms in November 1985 caused debris flow and flooding in northern Virginia and West Virginia. The event caused $1.3 billion in damage and resulted in 70 deaths. In 1969 the destruction created by Hurricane Camille included 150 deaths and more than $100 million in property damage.

Small-scale landslides are known to occur on steep slopes and can sometimes block roadways. The Virginia Department of Transportation makes emergency repairs as needed. On occasion a major landslide can block a roadway for as much as two weeks, as happened some years ago long Route 600 in Smyth County. Heavy rains and the annual freeze-thaw cycle can trigger these landslides.

Risk Assessment

The Mount Rogers region is mountainous in nature, and its steep slopes make parts of the region susceptible to landslides. The hazard-prone areas have been generally mapped by the U.S. Geological Survey, as shown in Image No. 11.

Image No. 11: Generalized Landslide Image of Southwest Virginia



Source: "Landslide Overview Map of the Conterminous United States," Geological Survey Professional Paper 1183 (1983), as modified by the MRPDC. The Mount Rogers region is shown in the area shaded with slanting lines.

[71] "Debris-Flow Hazards in the Blue Ridge of Virginia," U.S. Geological Survey Fact Sheet 159-96, 1996.

Certain types of rocks and geologic conditions, when they occur on slopes, make an area prone to landsliding. These types include fine-grained clastic rocks (those consisting mainly of silt and clay-sized particles), highly sheared rocks and loose slope accumulations of fine-grained surface debris, which give way during times of intense or sustained rainfall.[72] Steep slopes also can add to the likelihood of landslides. Debris flows, for instance, are known to occur mainly on slopes steeper than 25°.[73]

Probability and Frequency

There is no accepted method for determining the likelihood of a landslide in the Mount Rogers region. Given the relative lack of historical data on catastrophic landslides affecting the region, our best guess is a major landslide incident appears to be unlikely.

Landslides are not well understood in the Mount Rogers region. Most geologic studies have been focused on mineral resources (especially coal) of economic importance. Basic geologic mapping is only beginning to get underway in the region. More information will be needed before any detailed risk assessment can be made for localities in the Mount Rogers region.

Exposure

Please see the image above (Generalized Landslide Image of Southwest Virginia) for a visual depiction of potential landslide risk areas in the local region.

Generally speaking, the areas posing the greatest landslide risk include the pink and red regions. The pink regions include parts of Washington, Smyth and Grayson counties and a corner of Carroll County. The red regions include much of Carroll County and the border area between Washington, Smyth and Grayson counties.

Consequences

Landslides can damage or destroy roads, railroads, pipelines, utilities and infrastructure, forests, fisheries, parks and farms. Damages can include economic losses to local, state and federal agencies – because of the impacts to public infrastructure – and to the private sector for impacts to land and buildings. When located near communities, sudden landslides also can cause death.

Given the lack of detailed mapping and localized geological data for the Mount Rogers region, there is no way to make any detailed risk assessment for this hazard at this time.

[72] "Landslide Overview Map of the Conterminous United States," Geological Survey Professional Paper 1183 (1983).
[73] "Map Showing Inventory and Regional Susceptibility for Holocene Debris Flows and Related Fast-Moving Landslides in the Conterminous United States," by Earl E. Brabb, Joseph P. Colgan and Timothy C. Best, U.S. Geological Survey, at http://geopubs.wr.usgs.gov/map-mf/mf2329.

SEVERE WINTER STORMS and ICE

Description

Blizzards represent the worst of the winter season, combining heavy snowfall, high winds, extreme cold and ice storms. Severe winter storms can be characterized by heavy snowfall but lacking the severity usually associated with blizzards. They often begin as mid-latitude depressions or cyclonic weather systems and sometimes follow the jet stream.[74]

For the Mount Rogers region storm systems travel in from the Midwest and Tennessee Valley, from the Gulf Coast region and sometimes as a result of a major coastal storm that passes inland. On the northern side, extreme cold weather and Arctic cold fronts move in from Canada and are known to sweep into the Mid-Atlantic region. The severity of these storms may result from high snowfall accumulations that lead to major snowdrifts and blizzard conditions or that later melt and cause flooding. Wetter storms may have only limited amounts of snow but pack a wallop due to accumulations of ice. A light covering of ice can easily create numerous traffic accidents. Both ice and heavy snow can tear down tree limbs, trees, power lines and telephone lines, creating major disruptions that sometimes cannot be cleared up for weeks.

History

The historical record for snowstorms and blizzards in the Mount Rogers regions gives numerous examples of how bad these storms can get. Though the data reported below in Table No. 22 only covers a 10-year period, major winter events in the region resulted in seven federal disaster declarations and at least four state emergency declarations.

Table No. 22: Major Winter Storms, Cold And Ice
Mount Rogers Region, Virginia 1993-2003

DATE	LOCALITIES	DESCRIPTION
4-28-03	Wythe County	Severe winter storm, near record snowfall, heavy rain, flooding, and mudslide. 39 jurisdictions had disaster declarations. Wythe qualified in April for public assistance as result of the March storm.
3-30-03	Bland, Carroll, Grayson, Smyth, Wythe, Galax	Winter storm with heavy snow that began during the predawn hours of the 30th and continued through the early afternoon. Snow accumulated 6-12", brought down numerous tree limbs and power lines, resulting in more than 50,000 power outages.
2-15-03	Bland, Grayson, Wythe	**State emergency declaration** due to severe winter storm, impassable roads and flooding. SW Virginia got more than 4" of rain. Evacuations from homes in Bland and Wythe counties. Public assistance for debris removal, emergency protection and repair of damaged public facilities.
12-11-02	Carroll, Galax	**State emergency declaration** due to icy conditions creating massive power outages. Accretions of ¼" of ice. An icy winter storm followed on Dec. 13.
12-04-02	Bland, Carroll, Grayson, Smyth, Washington, Wythe, Galax.	Winter storm affected a wide area of SW Virginia. Snowfall amounted to 5-10" and ice of 1" or more in Carroll and Floyd counties. Numerous traffic accidents.

[74] Severe winter storms section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997.

May 2002	Bland, Carroll, Wythe, Bristol, Galax	Freeze damage affected Christmas tree growers. USDA was working to address the problem.
2-28-00	Bland, Carroll, Grayson, Smyth, Washington, Wythe	Severe winter storm. 107 jurisdictions had disaster declarations for winter storm from Jan. 25-30, 2000.
1-25-00	Bland, Carroll, Grayson, Wythe, Galax	**State emergency declaration** due to winter storm with high winds that dumped up to 18" of snow across much of the state, with drifting and blizzard conditions. Local storm occurred on Jan. 29. Snow mixed with sleet amounting to 4-8" inches, 11" in higher elevations.
3-15-99	Bland, Carroll, Smyth, Wythe, Galax	Winter storm developed with rain and sleet changed to a wet snow early in the morning. Snow amounts of 4-8", with up to 10" in the higher elevations. The snow downed power lines and small trees, resulting in power outages.
3-03-99	Bland, Carroll, Grayson, Smyth, Wythe, Galax	Winter storm resulted from rain changing to sleet and then snow, with accumulations of 6-12". Numerous motor vehicle accidents. Motorists stranded for 5-6 hours on I-77.
12-23-98	Bland, Carroll, Grayson, Smyth, Wythe, Galax	Ice storm created ice accretions of ½" and sometimes as much as 1". Ice downed tree limbs and power lines and created numerous power outages. Many traffic accidents and some injuries due to ice-covered roads and bridges.
1-28-98	Bland, Carroll, Grayson, Smyth, Wythe, Galax	**State emergency declaration** for severe winter storm with heavy snowfall in the western part of the state causing riverine flooding. Snowfall of 15-32" closed schools, businesses & church services & stranded people in vehicles & homes. Numerous traffic accidents. A charter bus overturned on I-81 near Marion, injuring 20 people. I-81 was closed for several hours during the height of the storm. Power lines, tree limbs and trees were knocked down.
12-29-97	Bland, Carroll, Grayson, Smyth, Wythe, Galax	Heavy winter snowstorm produced accumulations of 5-10", with 4-7" in Bland County. Bad road conditions resulted in numerous traffic accidents.
3-28-96	Bland, Carroll, Wythe, Galax (Bath County hardest hit)	Ice storm with freezing rain all day created significant ice cover above 1900 feet. Ice downed tree limbs, power lines, telephone lines. Numerous power outages and some traffic accidents.
2-02-96	Bland, Carroll, Grayson, Smyth, Washington, Wythe, Bristol, Galax	**State emergency declaration** for a winter storm with heavy snow, followed by extreme cold Feb. 3rd -6th. Burkes Garden in Bland County recorded 22° below zero. Most locations had morning lows on the 5th of zero to 12° below zero. Emergency declaration based on an Arctic air mass moving across state Feb. 1-4, with potential to cause widespread power outages.
1-06-96	Bland, Carroll, Grayson, Smyth, Wythe, Galax	**Blizzard of 1996**. **State emergency declaration** for a predicted winter storm with blizzard conditions and snowfall of 12-24" expected. **Statewide disaster declaration**. Occurred Jan. 6-13.
Winter of 1995-96	VDEM "Virginia Winters" account	Unusually heavy snowfall for the winter. Burkes Garden had 97", while Bland had 62". Some schools lost up to 15 days due to snow.
3-28-94	Bristol	Severe ice storms, flooding
3-10-94	Bland, Carroll, Grayson, Smyth, Washington, Wythe	Severe ice storms, flooding. May be related to the **state emergency declaration** of March 2, 1994.
3-12-93 to 3-13-93	Bland, Caroll, Grayson, Smyth, Wythe, Galax (affected a region from Florida to New England)	**Blizzard of 1993**. 43 jurisdictions received disaster declarations statewide. Extreme cold and heavy snowfall, along with high winds, sleet and freezing rain left many motorists stranded. $5 million property damage. It was the biggest storm in a decade in Virginia. SW VA got 24-42" of snow. Interstate highways were closed and emergency shelters were opened to house up to 4,000 motorists.

Source: Virginia Department of Emergency Management and National Climatic Data Center.
Note: Items with dates appearing in boldface and shading resulted in presidential disaster declarations.

Major storms such as the Blizzard of 1993 closed down interstate highways, stranded motorists in their vehicles and trapped people in their homes. The event also brought high winds, sleet and freezing rain, adding to the disruptions created by the snowfall. In southwest Virginia, snowfall ranged from 24 to 42 inches in what was the largest snowstorm in a decade for the state.

The Blizzard of 1996 (January 6-13) began in the southeastern states and moved into the northeastern states to cover the entire eastern seaboard. Snowfall amounted to one to four feet, with the greatest impacts for Virginia and West Virginia. On a statewide level, Virginia had 48 inches of snow, followed by West Virginia with 43 inches of snow. Much of the same region experienced two more snowstorms that dumped up to 12 inches more within the next 10 days.[75]

Table No. 23: Annual Snowfall Data Mount Rogers Region, Virginia

Locality	Avg. Annual Total Snowfall	Time Period
Abingdon	16.3"	12/69-3/03
Bland	25.5"	9/51-3/03
Burkes Garden	46.3"	8/48-3/03
Byllesby	11.4"	5/67-3/03
Chilhowie	19.2"	4/52-9/76
Damascus	22.0"	8/48-7/74
Galax Radio	19.1"	8/48-3/03
Hillsville	18.9"	8/48-3/03
Independence	20.2"	1/53-6/89
Mendota	15.6"	8/48-9/76
Saltville	13.4"	1/30-3/62
Speedwell	8.0"	8/48-9/85
Troutdale	20.2"	8/48-3/03
Wytheville	19.9"	1/30-3/03

Source: Period of Record Monthly Climate Summary, Southeast Regional Climate Center at http://cirrus.dnr.state.sc.us.

Snowstorms pose a threat not only because of dangerous driving conditions and downed power lines, but also due to the melting that can lead to flooding. During the 2002-2003 winter season, severe winter storms later created flooding problems in Bland, Grayson and Wythe counties, with Wythe declared eligible for federal disaster assistance.

Due to variable topography and other factors, average annual snowfall amounts vary greatly throughout the Mount Rogers region, based on available weather records shown in the accompanying Table No. 23, shown at left. The data covers time periods as long as 73 years.

Risk Assessment

Probability and Frequency

Winter storms are a regular part of the weather regime for the Mount Rogers region. The severity of the season varies from year-to-year and can be highly variable among the localities for any given storm event. The variability can be due to differences in elevation, differences in temperature and the track of given storm systems.

In recent years there have been at least 11 state and/or federal disaster declarations due to severe winter storms over a 10-year period, as shown in the table on Major Winter Storms, Cold and Ice. Based on this brief time period, it is likely localities in the Mount Rogers region will experience at least one major snow and/or ice storm per year with the potential to become a federal disaster.[76] The winter season typically runs from November to April of each year.

[75] From "Have Snow Shovel, Will Travel: A History of Snow Removal", online at the National Snow and Ice Data Center, http://nsidc.org/snow/shovel.html.
[76] Please note this estimate is based on only a short period of time and therefore is subject to inaccuracy.

The average winter season in the Mount Rogers region can create annual snowfall amounts ranging from 8 to 46 inches. The average snow season in Roanoke produces 23 inches per year (over 49 years) and in the Bristol-Johnson City-Kingsport, Tenn. area produces 15.6 inches per year (over 59 years).[77]

Exposure

Any major winter storm or blizzard is likely to affect the entire Mount Rogers region, with the most direct impacts affecting highways and power lines. Most snow-related deaths result from traffic accidents, overexertion, and exposure[78]. Sometimes also there is damage to buildings from collapsed roofs and other structural damage. There is no way that we know of to calculate the likely costs of a major winter snow or ice storm. The available data, through the National Climatic Data Center, reports damages by storm event, but this is not broken down by locality.

Consequences

Severe winter storms and ice can cause death and injury on the highways and trap people in their motor vehicles or in their homes due to impassable roads. Snowstorms also regularly result in the closing of schools; in some years, the local schools have been closed as much as 15 days due to winter conditions. Forecasts of impending snowstorms also regularly result in early school closings to reduce risk from bus and traffic accidents. Likewise, winter conditions can result in temporary disruptions of business activity, with workers advised to remain home until driving conditions improve.

Image No. 12: Generic Snow Scene

The Virginia Department of Transportation deals directly with the effects of snowstorms. On average in the past five years, VDOT has spent $80 million annually on snow removal. As a general rule, the first priority is to plow interstate highways, major primary roads and secondary roads. Plowing in subdivision and residential areas are the second priority during winter storms.[79] VDOT seeks to get ahead of snow conditions on the roadways through pre-treatments with liquid chloride and close monitoring of storm conditions and incoming storms.

For American Electric Power the main concern is icing, which can tear down overhead power lines. AEP is sometimes hampered in its efforts to restore power during major snowstorms due to the poor condition of the roads. The state's system of highway maintenance, carried out by several private contractors, at times creates uneven results during snow clearing.

[77] From total snowfall records kept by the National Climatic Data Center.
[78] From the "Snow Facts" section of the National Snow and Ice Data Center.
[79] From "VDOT Budgets for Winter Weather," Nov. 25, 2003, VDOT news release found at www.virginiadot.org.

THUNDERSTORMS and LIGHTNING

Description

Thunderstorms arise from atmospheric turbulence caused by unstable warm air rising rapidly into the atmosphere, enough moisture to form clouds and rain and an upward lift of air currents caused by colliding warm and cold weather fronts, sea breezes or mountains.[80] Thunderstorms are always accompanied by lightning, but they may also be associated with heavy rains, hail and violent thunderstorm winds.

Thunderstorms occur most often during the spring and summer months. Nationwide the average storm is 15 miles wide and generally last less than 30 minutes at any given location. Some storm systems have been known to travel more than 600 miles.

History

Storm events reported to the National Climatic Data Center reflect the kind of activity and damages resulting from high winds and thunderstorm winds. Describing the data can be problematic, since storms often travel over wide regions. The reported damages represent those for the entire storm event and are not usually limited to a given locality. The data given in Table No. 24 is offered only as a rough guide to thunderstorm history in the Mount Rogers region.

Table No. 24: Storm Event History For Thunderstorm Winds
Mount Rogers Region, Virginia

Location	Time Period	No. Of Years	No. Of Events	Avg. Per Year	Reported Damages
Bland County	May 1989-May 2003	14	16	1.1	$243,000
Carroll County	June 1960-June 2003	43	40	0.9	$1,273,000
Grayson County	May 1962-May 2003	41	30	0.7	$459,000
Smyth County	April 1972-Feb. 2003	31	24	0.8	$335,000
Washington County	June 1995-June 2003	8	49	6.1	$795,000
Wythe County	July 1962-Feb. 2003	41	26	0.6	$603,000
City of Bristol	July 1980-Aug. 2002	12	10	0.8	$92,000
City of Galax	Jan. 1998-Aug. 2001	3	3	1	0

Source: Reported storm events data from National Climatic Data Center at www4.ncdc.noaa.
Note: Damages include property and crop damage (crop damages were reported in Carroll, Washington and Bristol).

Another event, on July 4, 1997, captured in the NCDC data involved a **supercell thunderstorm** and associated severe thunderstorms affecting a region stretching from Tazewell to Pittsylvania counties. Thunderstorm winds estimated at 60-80 mph and hail the size of golf balls damaged at least 29 homes, 16 mobile homes, five outbuildings, four businesses and a church in a two-mile path near Wytheville. There was also widespread damage to vehicles, roofs, sidings, satellite dishes, trees and a large sign knocked down by the winds. Wytheville Community College

[80] Atmospheric hazards section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997.

sustained 100 broken windows. Hail drifts amounted to six to eight inches deep in several locations. The event caused an estimated $300,000 in property damage.[81]

A **supercell thunderstorm**, while rare, is the often the most violent known form of thunderstorm and is associated with tornadoes, damaging straight-line winds and large hail. These events are defined as long-lived thunderstorms with a persistent rotating updraft. They often contain mesocylones, or storm-scale regions of rotation typically two to six miles in diameter that may produce tornadoes.[82]

Lightning

Thunderstorms are always accompanied by lightning, which can cause fires, injury and death. Florida is known for having the greatest number of thunderstorms and the highest density lightning strikes in the contiguous United States.

Lightning becomes a problem when the discharge of a lightning bolt connects with an object or surface on the ground. Lightning will be considered together with thunderstorms in judging the importance of this hazard for the Mount Rogers region.

Risk Assessment

Probability and Frequency

Southwest Virginia experiences 60-80 thunderstorms on average per year. Most of these occur during the summer months, extending from May through September, with July the peak month for thunderstorms statewide, according to the state climatology office. This is moderate compared to other parts of the country with more than 130 thunderstorms annually.[83] During the peak of the thunderstorm season in the local region, storms may roll through at the rate of three or four per week, which is relatively frequent.

Exposure

People and property throughout the Mount Rogers region are subject to damages and injuries created by lightning and thunderstorms. But any individual storm is likely to affect only a very limited area.

Virginia experiences a moderate number of thunderstorms and lightning strikes compared to other parts of the country, according to research cited by FEMA.[84] Thunderstorms in the Mount Rogers region typically last 70-80 minutes in any given location, which falls in the mid-range for

[81] Details taken from the on-line storm events database maintained by the National Climatic Data Center.
[82] Definition from "A Comprehensive Glossary of Weather Terms for Storm Spotters," NOAA Technical Memorandum NWS SR-145, September 1996. Found at www.srh.noaa.gov/oun/severewx.
[83] From Map 2-2, op.cit.
[84] From atmospheric hazards section, *Multi-Hazard Identification and Risk Assessment* report, July 1997.

storm duration nationwide. In some areas thunderstorms last 130 minutes or more, based on findings by the National Weather Service for the years 1949-1977.[85]

Consequences

These storms can cause serious structural damage to buildings, start forest fires and wildfires, blow down trees and power lines, and cause death. On rare occasions, events such as the supercell thunderstorm from July 1997 can cause widespread damage, as previously discussed on the history section.

Nationally, Virginia falls in the mid-range for lightning fatalities, based on the cited research through the National Oceanic and Atmospheric Administration. States such as Florida, North Carolina, New York and Tennessee rank far ahead of Virginia.[86] The lightning that accompanies thunderstorms in the Mount Rogers region averages 4-6 strikes per square kilometer, which is relatively low.[87]

It is not possible based on available data to quantify the impacts of thunderstorms and lightning for localities in the Mount Rogers region. Available data from the National Climatic Data Center, which tracks incidents of thunderstorms and thunderstorm wind damage, is reported on a regionalized basis often covering numerous localities as a storm system moves through. Data resources will have to improve in the future to be able to make these calculations on the local level.

[85] From Map 2-1, op.cit.
[86] "Lightning Fatalities, Injuries and Damage Reports in the United States from 1959 to 1994," NOAA Technical Memorandum NWS SR-193, available at www.nssl.noaa.gov/techmemos.
[87] From Map 2-3, op.cit.

TORNADOES and HURRICANES

Description

A tornado appears as a rapidly spinning vortex or funnel of air extending to the ground from an overhead storm system (usually a thunderstorm)[88]. Tornadoes come in many sizes, ranging from several yards to more than a mile wide. The severest tornadoes can achieve wind speeds of more than 300 mph, though most are 100 mph or less. The weakest tornadoes may last only about a minute, while the stronger ones may continue for 30 minutes at a time and travel miles before dissipating. Virginia is said to have an average of seven reported tornadoes per year (1950 through 2001), though the actual number of tornadoes may be as much as three times higher.[89]

Statistically the peak month for tornadoes in Virginia is July, though the tornado season goes from spring through fall. Tornadoes spring from an estimated 1% of all thunderstorms; of the group that produces tornadoes, only about 2% are considered violent with winds over 200 mph (categories F3, F4 and F5 on the Fujita scale). Tornadoes also can be associated with hurricanes, though hurricanes are not a significant factor in southwest Virginia.

Table No. 25: FUJITA TORNADO MEASUREMENT SCALE

Category	Name	Description
F0	Gale tornado (40-72 mph)	Light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to sign boards.
F1	Moderate tornado (73-112 mph)	Moderate damage. The lower limit is the beginning of hurricane wind speed; peel surface off roads; mobile homes pushed off foundations or overturned; moving autos pushed off roads.
F2	Significant tornado (113-157 mph)	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars turned over; large trees snapped or uprooted; light-object missiles generated.
F3	Severe tornado (158-206 mph)	Severe damage. Roofs and some walls torn off well-built houses; trains overturned; most trees in forest uprooted; cars lifted off ground and thrown.
F4	Devastating tornado (207-260 mph)	Devastating damage. Well-built houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado (261-318 mph)	Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

The accuracy of expected damage at particular wind speeds has never been scientifically proven.
Source: National Oceanic and Atmospheric Administration (NOAA) at www.outlook.noaa.gov.

[88] From FEMA's Multi-Hazard Identification and Risk Assessment report, July 1997.
[89] Taken from "Virginia Tornadoes," a narrative found on-line in the library section at www.vaemergency.com for the Virginia Dept. of Emergency Management.

As seen in Table No. 25, shown above, tornadoes are measured on the Fujita Scale, with categories ranging from F0 to F5. The categories are defined according to wind speed and the types and severity of damage caused.

Parts of southwest Virginia show some tendency toward tornadoes in an area that extends from Tennessee into Bristol, possibly due to the lay of the land and its influence on storm systems.[90]

History

Between 1950 and 1995, Virginia experienced six tornadoes per year or 1.6 tornadoes annually per 10,000 square miles.[91] Two storms per year on average were rated as strong or violent (F2-F5), with 0.5 such storms per 10,000 square miles per year.

Table No. 26
Tornado History: Mount Rogers Region
1950 through May 2003

Locality	Date	Time	Dead	Hurt	F Scale
Bland Co.	-	-	-	-	-
Carroll Co.	Aug. 1, 1965 Aug. 21, 1977 July 4, 1979	0230 1700 1620	0 0 0	5 0 0	F1 F2 F1
Grayson Co.	July 10, 1959	1500	0	0	F1
Smyth Co.	April 4, 1974 Jan. 25, 1975 June 5, 1975 July 13, 1975	0405 2335 1815 1900	0 0 0 0	3 2 0 0	F3 F2 F0 F1
Washington Co.	April 30, 1953 June 10, 1953 June 3, 1962 April 4, 1974 Jan. 25, 1975 April 30, 1990	1845 1500 1600 0400 2330 1725	0 0 0 1 0 0	0 0 0 1 0 0	F0 F1 F2 F3 F2 F0
Wythe Co.	-	-	-	-	-
City of Bristol	April 4, 1974	0300	0	0	F0
City of Galax	-	-	-	-	-
Totals:	**15 events**		**1**	**11**	

Source: Tornado Project Online at www.tornadoproject.com; also, Storm Events Page of the National Climatic Data Center at www4.ncdc.noaa.gov for tornadoes from 1996 through May 2003.

For the Mount Rogers region there have been 15 reported tornadoes from 1950 through May 2003, with one person killed and 11 people injured. The highest intensity ever recorded for these storms was F3. See Table No. 26, at left, for more details.

On the Fujita scale, an F3 category tornado is considered severe, with winds up to 206 mph. This fits with the FEMA Wind Zone III designation for the region. By definition Zone III communities are known to experience winds of 160-200 mph.

The tornadoes of April 4, 1974 were part of what is known as the "Super Outbreak," when severe thunderstorms at the leading edge of a cold front moved into southwest Virginia. Eight tornadoes struck statewide, killing one person and hurting 15. The destruction affected more than 200 homes

[90] Ibid.
[91] As reported by the National Oceanic and Atmospheric Administration.

and barns and more than 40 mobile homes and trailers. The storm event in total spawned 148 tornadoes, killed 315 people and injured 5,484. “Super Outbreak” created the most tornadoes ever recorded in a 24-hour period and the worst tornado outbreak since Feb. 19, 1884.

One of the tornadoes, rated at F0 to F1, struck near Bristol, demolishing several mobile homes and hurting four people. A stronger F3 tornado hit the Saltville area, traveling up the valley of the North Fork Holston River from Washington County, then following Tumbling Creek into Poor Valley and traveling up the Poor Valley to Cardwell Town. The storms resulted in one dead, one injured and destruction of two houses, two mobile homes, a church and three barns. There was also damage to 42 homes, two mobile homes and the roof of a high school.[92] Wind damage was reported in Bland and Wythe counties.

Hurricanes

Generally speaking, the Mount Rogers region does not have hurricanes and is not considered hurricane-susceptible like communities all along the east coast. Hurricanes become a factor on those rare occasions when the storm systems take an inland route as they pass over the Mid-Atlantic region. Two of the most significant hurricanes in recent decades affecting the Mount Rogers region were *Hurricane Agnes* (June 1972) and *Hurricane Hugo* (September 1989).

Hurricane Agnes, originating off the coast of the Yucatan Peninsula in Mexico, became a tropical storm on June 16, 1972 and then a hurricane in June 19, 1972. It crossed the Florida panhandle on June 19 and passed through Georgia, South Carolina and North Carolina before returning to the Atlantic Ocean to regain strength. The storm made landfall a second time on June 22, 1972 in southeastern New York and moved west across the southern tier of New York and into north-central Pennsylvania, where the $3.1 billion hurricane made its greatest impact.[93]

Though the local record is scanty for this storm, 106 jurisdictions in Virginia qualified for a presidential disaster declaration due to widespread flooding. Those included Smyth County and the City of Galax. Most notable for damage caused by flooding, Agnes dropped an average of 6-10 inches of rain over the Mid-Atlantic region from June 20-25, 1972. The storm in Virginia created an estimated $126 million in damages and resulted in 13 deaths.[94]

Hurricane Hugo began as a cluster of thunderstorms moving west off the coast of Africa. As the storm system passed over the Atlantic Ocean, it gained strength to become a tropical depression and then a hurricane, on Sept. 13, 1989. Once classified as a Category 5 storm (highest intensity hurricane) on the Saffir-Simpson Scale, Hugo did great damage in the Carribean and Puerto Rico. By Sept. 19 the storm had weakened and moved back over the Atlantic, where Hugo regained strength and became a Category 4 hurricane with winds up to 135 mph when it made landfall near Charleston, S.C. on Sept. 22, 1989. By the time Hugo passed west of Charlotte, N.C., it had weakened to a tropical storm with peak winds of 87 mph. The storm continued tracking north over southwest Virginia and West Virginia; the Appalachian Mountains helped

[92] Ibid.
[93] From “The Life of Hurricane Agnes,” a narrative found at www.erh.noaa.gov/er/marfc/Flood/agnes.html.
[94] Ibid.

weaken the storm further as it continued into western New York and passed out of the country.[95] In the end six Virginians died as a result of Hugo.

As the storm passed over the Appalachians, orographic effects were thought to cause locally heavy rainfalls of more than six inches over western North Carolina and southwest Virginia, causing small stream flooding. Orographic effects are defined as those caused by the presence of mountains; most commonly, this occurs when air rises over the mountains and then cools, creating condensation and rainfall.

In total Hugo was estimated as a $9 billion storm in damages and economic losses, with $7 billion of that total occurring on the mainland, particularly in the Carolinas.[96]

Risk Assessment

Probability and Frequency

The Mount Rogers region appears to face a low risk of tornadoes and hurricanes. FEMA classifies the region under Wind Zone III, meaning winds can reach speeds ranging from 160 mph to 200 mph. The region also, based on historical information, experiences less than one tornado per 1,000 square miles. Tornadoes are rare for the Mount Rogers region.

Table No. 27: FEMA High Wind Matrix
Tornado and Hurricane Risk

		Wind Zone			
		I	II	III	IV
No. of Tornadoes per 1,000 sq. miles	< 1	Low Risk	Low Risk ✹	Low Risk ✹	Moderate Risk
	1-5	Low Risk	Moderate Risk ✹	High Risk	High Risk
	6-10	Low Risk	Moderate Risk ✹	High Risk	High Risk
	11-15	High Risk	High Risk	High Risk	High Risk
	> 15	High Risk	High Risk	High Risk	High Risk

Note: ✹ indicates areas located in hurricane-susceptible regions.

Exposure

A tool to judge damage potential from tornadoes and hurricanes can be found in a FEMA publication called *Taking Shelter From the Storm: Building a Safe Room Inside Your House*.[97] The tool appears above as a matrix in Table No. 27.

[95] From "Hurricane Hugo, September 10-22, 1989," a national disaster survey report by the National Oceanic and Atmospheric Administration, May 1990.
[96] Ibid.
[97] FEMA publication 320, 1st edition, October 1998.

The matrix and the wind zone assignments are based on 40 years of tornado history and more than 100 years of hurricane history in the United States, as well as research by the Wind Engineering Research Center at Texas Tech University. This serves as the basis for a low risk rating for the Mount Rogers region.

Consequences

Tornadoes, though rare for the Mount Rogers region, have been known to achieve an F3 intensity rating, based on the Fujita scale. These most severe known tornado incidents have occurred in Smyth and Washington counties. An F3 intensity tornado contains sufficient power to tear roofs and walls from well-built homes, uproot most trees, and lift objects such as automobiles off the ground and send them flying through the air. These storms can generate wind speeds of 158-206 mph.

As for hurricanes, the Mount Rogers region stands far inland and is not part of the coastal zone region where hurricanes cause most of their damage. Generally speaking, the local region experiences the outer effects of hurricanes; this can include high winds and heavy rainfall. **Since heavy rainfall mainly results in flooding, hurricane impacts will be covered in the section on flooding.**

WILDFIRES

Description

Wildfires occur as a regular part of the natural environment and are fueled by trees, brush and grasses. The three primary factors that influence these fires are topography, fuel and weather. Nationwide, the most frequent and worst of the wildfires occur in the western states, due to the dry climate and the prevalence of conifer and brush fuel types.[98]

Wildfires also occur as a result of human actions, with increasing numbers of people choosing to live in wooded and wildland settings (described as the wildland urban interface), a factor that is also an issue for the eastern states, including the Mount Rogers region.

It is possible to group wildfires into four categories, as follows:

Wildland fires occur in national forests and parks and are fueled by natural vegetation. Federal agencies typically hold the lead role for fire management and suppression for this group of fires.

Interface or intermix fires happen at or near the junction between natural vegetation and the built environment.

Firestorms are high-intensity fire events that are impossible to control or suppress until conditions change or the available fuel is gone. Firestorms have been a particular problem in the western states.

Prescribed fires and prescribed natural fires include those that are intentionally set and those that are allowed to burn as part of a fire management program to help clear out excessive accumulations of vegetative fuels.

History

Wildfires in the Mount Rogers region are not as prevalent or as damaging as the massive fire events that occur every year in the western states. But the risks still exist due to the amount of forested land in the region, presence of contributing factors (steep slopes, pine woods, wildfire history), and residential development in remote, wooded areas throughout the region.

Table No. 28: Fire Data - 1995-2001*
Mount Rogers Region

County	Total Fires	Burned Acres	Total Damaged	Total Saved
Bland	32	90.7	$24,485	$1,307,300
Carroll	147	334.7	$266,241	$16,154,400
Grayson	79	229.3	$54,358	$1,706,200
Smyth	82	128.8	$29,604	$1,070,200
Washington	116	1045.3	$263,786	$2,127,200
Wythe	49	166.5	$91,430	$793,450
Totals:	**505**	**1995.3**	**$729,904**	**$23,158,750**

* Data downloaded from the ForestRIM system developed by VDOF.

[98] Wildfire hazards section, FEMA's *Multi-Hazard Identification and Risk Assessment* report, July 1997.

From 1995 through 2001 the Mount Rogers region had roughly 500 fires causing an estimated $730,000 in damages (see Table No. 28, above). Total property saved from destruction was estimated at more than $23 million, according to data by the Virginia Department of Forestry (VDOF). The greatest number of fires occurred in Carroll County. Though it had fewer fires during the seven-year period, Washington County sustained fire damage to the largest total land mass.

**Table No. 29: Causes of Fires in Mount Rogers Region*
1995-2001**

FIRE CAUSES	Bland	Carroll	Grayson	Smyth	Wash.	Wythe	TOTALS
debris burning	17	75	43	34	67	21	**257**
incendiary	12	24	8	36	29	4	**113**
equipment use	-	12	8	4	1	6	**31**
miscellaneous	2	13	7	4	5	9	**40**
smoking	-	4	2	1	8	3	**18**
children	1	13	6	-	3	3	**26**
campfire	-	4	2	2	1	-	**9**
lightning	-	2	2	-	2	2	**8**
railroad	-	-	-	-	-	1	**1**
not given	-	-	1	1	-	-	**2**
Total Fires:	**32**	**147**	**79**	**82**	**116**	**49**	**505**

* Data as downloaded from the GIS-based ForestRIM system developed by VDOF.

VDOF data also points to debris burning and incendiary (arson) sources as the most common cause of fires in the Mount Rogers region. Those two sources accounted for 370, or 73%, of the 505 fires occurring between 1995 and 2001. Less frequent fire causes included equipment use, miscellaneous, smoking and children (see Table No. 29).

On the federal level, catastrophic fire losses in the western states have led to the development of the National Fire Plan[99] and the Healthy Forests Initiative.

The National Fire Plan has resulted in more spending by state and federal agencies for improved prevention of wildfires. In the George Washington and Jefferson National Forests, which include the Mount Rogers region, the added funding supported efforts to reduce levels of fire-prone fuels and to establish a Type I firefighting crew.[100] The National Fire Plan aims to provide sufficient resources for firefighting, rehabilitate fire-damaged ecosystems, reduce levels of fire-prone fuels found in the forests, and reduce fire risk faced by woodland property owners.

[99] Created in response to the record-setting 2000 fire season.
[100] On-line information found under the "Fire and Aviation" section for the George Washington and Jefferson National Forest page at www.southernregion.fs.fed.us/gwj/forest/fire/index.shtml.

Image No. 13: View of the George Washington and Jefferson National Forests.

The Healthy Forests Initiative, promoted by the Bush administration, is a long-term plan by federal agencies to improve management of federal lands and expedite forest and rangeland restoration projects. This effort is focused on communities near the wildland urban interface, in high-risk municipal watersheds, in watersheds containing habitat for threatened and endangered species, and where ecosystems are being destroyed by insect and disease epidemics and face increased threat of catastrophic wildfire. The wildland urban interface, particularly where rural housing development intermingles with the forest, is a concern for the Mount Rogers region.

Risk Assessment

The Mount Rogers region covers an estimated 1.77 million acres of land. Of that total, an estimated 1 million acres of land (roughly 58%) is classified as forestland, with nearly all used as timberland (see Table No. 31 at the end of this section).[101]

Image No. 14: Logo for the ForestRim Program.

Areas subject to fire risk include the forestlands and places where people are building homes and residential subdivisions in wooded settings.

Virginia Department of Forestry (VDOF) criteria for determining areas of highest risk take into account factors such as density of historical wildfires, nature of the land cover (pines are more flammable than hardwoods), steepness and orientation of slope, population density, distance to roads, road density and developed areas, and presence of railroads.[102] VDOF is incorporating its data into a GIS-based mapping system called ForestRIM to help make wildfire risk assessments and to identify woodlands home communities. ForestRIM was still in development in 2004, and its data outputs (as reported on this study) should be considered preliminary.

[101] From 2001 Forest Inventory data generated through the USDA Forest Service at http://ncrs2.fs.fed.us.
[102] Metadata information from the Mount Rogers PDC Wildfire Risk Assessment by the Virginia Dept. of Forestry. This can be downloaded at www.wdof.org/gis/dwnld-Mt-Rogers-faq.shtml.

Probability and Frequency

VDOF statistics for the state show most fires occur during the spring fire season (February-May) and on a lesser level during the fall fire season (October-December). More fires occur during these periods due to drier weather conditions, higher winds and the presence of cured fuels that can easily ignite. Causes of fires statewide include: open burning (30%), arson (20%), smokers (14%), miscellaneous (11%), children (9%), equipment use (7%), railroads (5%), lightning (3%), and campfires (1%).[103]

In any given year on average, the Mount Rogers region may experience 70 wildfires, based on the state forestry data from 1995 through 2001.

Exposure

Information on wildfire risk was being developed through VDOF and its GIS-based ForestRIM program, which mapped areas of risk into categories of low, moderate and high, based on criteria described above. The VDOF data did not include information on wildfires occurring on federal lands (which would include the national forests and the Mount Rogers National Recreation Area).

The VDOF wildfire risk data as available in early 2004 showed:

- **Carroll** and **Washington** counties contained the largest amount of land subject to high risk of wildfire (more than 100,000 acres for each county).
- **Washington County** appeared to have the highest number of woodland homes subject to high risk of wildfire. Next in line was Carroll County.
- Substantial regions of high wildfire risk were also apparent for **Smyth County** (in its midsection and far northwestern corner, roughly 70,000 acres) and **Grayson County** (all along its eastern border and generally along the U.S. Rt. 58 corridor, roughly 60,000 acres).
- Areas with lesser acreages subject to high risk of wildfire included **Bland** (approximately 27,000 acres) and **Wythe** counties (roughly 20,000 acres).

Loss estimates have been based on the preliminary data available through the ForestRIM program (for housing counts) and estimates (for housing values) as applied by the MRPDC.

The values shown in Table No. 30 reflect the estimated value of all woodland homes in the region. In any given wildfire, only a portion of this housing stock would be at risk of destruction. However, any given woodland home that catches on fire faces a high risk of substantial or total destruction in some of the more remote parts of the local region. We have no way of estimating the potential loss for any given wildfire event.

[103] From "Causes of Forest Fires in Virginia," by Virginia Dept. of Forestry at www.vdof.org/fire/fire-causes.shtml.

Table No. 30: LOSS ESTIMATES FOR WOODLAND HOMES
Mount Rogers Region, Virginia

Locality	Est. Number Homes at Risk	Total Value of Homes at Risk	Est. Total Land Mass at Risk
Bland County	265	$34,430,390	27,000 acres
Carroll County	712	$92,507,312	> 100,000 acres
Grayson County (incl. Galax)	258	$33,520,908	60,000 acres
Smyth County	475	$56,895,500	70,000 acres
Washington County	804	$96,303,120	> 100,000 acres
Wythe County	No data avail.	--	20,000 acres
City of Bristol	No data avail.	--	--
City of Galax	67	$8,705,042	--

Source: Data pulled from on-line ForestRim program of the Virginia Dept. of Forestry.

Consequences

People with homes in woodland communities can face a substantial risk of wildfire and catastrophic loss. These homes generally cannot be insured against loss, which places the entire financial burden on the homeowners. In some cases private housing developments in wooded settings contain narrow, poorly designed roads that cannot accommodate fire-fighting equipment. Other potentially serious issues include lack of access to a water supply, remote location, unidentified roads, and presence of vegetation (pines, broom sage) that is more prone to catch on fire. Wildfire can result in loss of property, injury and loss of life.

Table No. 31: Land Cover Information: Mount Rogers Region[2]
(2001 Forest Inventory Data by the USDA Forest Service)

County	All Land[1]	Forest Land				Non-forest Land
		Total	Timberland	Woodland	Reserved	
Bland	229,545	172,214	166,519	na	5,695	57,331
Carroll	308,115	162,291	160,499	na	1,792	144,141
Grayson	285,304	173,873	161,883	na	11,991	111,431
Smyth	289,337	183,428	178,103	na	5,325	105,909
Washington	368,481	192,734	191,190	na	1,544	174,119
Wythe	296,480	153,942	153,610	na	332	142,538
Total	**1,777,262**	**1,038,482**	**1,011,804**	**na**	**26,679**	**735,469**

1. This excludes a category called non-Census water, estimated at 3,311 acres.
2. This data is based on sampling methods and is considered most accurate at the state or multi-state level.

WINDSTORMS

Description

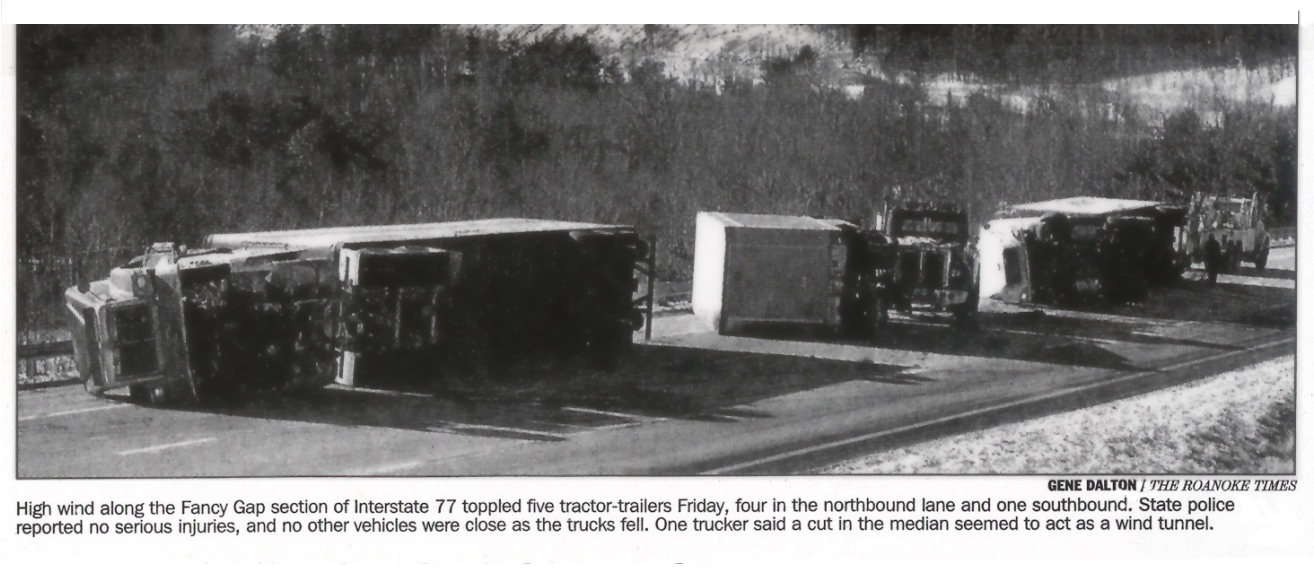
Wind can be defined as the motion of air relative to the earth's surface. Extreme wind events may come in the form of cyclones, severe thunderstorms, tornadoes, downbursts and microbursts.

Wind speeds may vary from 0 at ground level to 200 mph in the upper atmosphere. Nationwide the mean annual wind speed falls in the 8-12 mph range. Frequently, wind speeds reach 50 mph and sometimes exceed 70 mph. Coastal areas from Texas to Maine may experience tropical cyclone winds with speeds of greater than 100 mph.[104] The Mount Rogers region is located in Wind Zone III, with winds reaching up to 200 mph. A *special wind region* is known to occur in an area reaching from northeast Tennessee into southwest Virginia.[105]

History

High winds in the Mount Rogers region blow down trees and power lines and cause varying amounts of property damage. A wind tunnel effect observed in a *special wind region* reaching from northeast Tennessee into southwest Virginia sometimes blows tractor trailers off I-77 in Carroll County. Some winds have lifted trucks off the highway and deposited them some distance away, like the effects of tornadoes.[106] Image No. 15 occurred in January 2003.

Image No. 15: Effects of High Winds on I-77 near Fancy Gap in Carroll County, VA.



GENE DALTON / *THE ROANOKE TIMES*

High wind along the Fancy Gap section of Interstate 77 toppled five tractor-trailers Friday, four in the northbound lane and one southbound. State police reported no serious injuries, and no other vehicles were close as the trucks fell. One trucker said a cut in the median seemed to act as a wind tunnel.

The state transportation department in 2004 was testing a new highway warning system (overhead signs) designed to alert truck drivers to wind and fog incidents in the Fancy Gap area.

[104] Atmospheric hazards section, FEMA's *Multi-Hazatd Identification and Risk Assessment* report, July 1997.
[105] From FEMA's *Taking Shelter from the Storm: Building a Saferoom in Your House*, pub. 320.
[106] From "Wintry blasts topple trucks on I-77," Roanoke Times, Jan. 25, 2003.

The system is intended to help drivers avoid these hazards to the extent possible. In the Mount Rogers region, high winds have been known to tear down trees and power lines, blow in parts of buildings, and cause other kinds of property damage. An accounting of several recent high-wind incidents in the region is shown in Table No. 32.

Table No. 32
High Wind Incidents - Mount Rogers Region, Virginia

Date	Location	Description	Damages
10-5-95	Entire Mount Rogers region, plus much of SW VA	No description available.	$20,000 property
11-11-95	Bland, Carroll, Galax	Two windstorms occurred on same day.	$8,000 property
1-19-96	Carroll, Galax	No description available.	None reported
9-6-96	Carroll, Galax, Floyd, Franklin, Patrick	No description available.	$175,000 property, $200,000 crops
4-1-97	Carroll, Galax	Tractor-trailer blown over on I-77.	$7,000 property
2-4-98	Carroll, Galax, Patrick	Winds downed trees and damaged some mobile homes.	$15,000 property
3-3-99	Bland, along with Floyd, Giles, Montgomery, Pulaski	Winds downed trees and power lines.	$11,000 property
4-12-99	Carroll, Galax, Franklin, Patrick	High winds blew over a tractor-trailer on Rte. 58 and a mobile home (Patrick County). Winds blew over two tractor-trailers 5 miles south of Fancy Gap on I-77.	$14,000 property
1-13-00	Entire Mount Rogers region, plus much of SW VA	Winds downed large trees and power lines, caused minor property damage in all counties. Winds at 68 knots in Bland County.	$180,000 property
3-20-00	Smyth, Wythe	Winds downed trees and power lines.	$6,000 property
1-10-01	Carroll, Galax, Bedford	Winds of 65 knots blew over 3 tractor-trailers on I-77. Much damage in Bedford County with shingles and siding stripped off more than 90 homes. Winds also downed power lines, power poles and numerous trees.	$410,000 property
3-6-01	Carroll, Galax, Grayson, Patrick	Winds associated with a snowstorm downed trees and power lines. Winds blew in a wall and partly collapsed a roof on an auto repair shop in Carroll County.	$80,000 property
3-10-02	Carroll, Galax, Grayson	High winds downed trees across Grayson and Carroll counties.	None reported
12-25-02	All of Mount Rogers region, plus wide area of SW VA	Winds downed numerous trees and power lines. A tree fell on a house in Roanoke, damaging the roof and crushing the front porch.	$20,000 property
1-8-03	Carroll, Galax, Grayson, other parts of SW VA	Winds of 50 knots downed trees and power lines. Many downed trees in Grayson County damaged several homes.	$80,000 property
1-9-03	Carroll, Galax, Wythe, plus 6 other SW VA counties	Winds of 60 knots downed trees and power lines.	None reported
1-23-03	Carroll, Galax, Wythe, other parts of SW VA	Winds of 100 knots blew over 6 tractor-trailers on I-77, near Fancy Gap. Trees and power lines downed throughout region.	$50,000 property
2-22-03	All of Mount Rogers region, plus wide reaches of SW VA	Winds of 80 knots downed numerous trees and power lines. Many people lost power across the region. Roof blown off an outbuilding in Tazewell County.	$3,000 property
5-11-03	Bland County	Winds of 70 knots downed several trees and power lines.	None reported

Source: Storm events database from the National Climatic Data Center.

The details for these high wind events were drawn from the National Climatic Data Center's database. For some incidents, even when damages are reported, an accompanying description of the event is not always available.

Risk Assessment

Probability and Frequency

Of the high wind events reported to the National Climatic Data Center, some part of the Mount Rogers region experienced damaging winds at least 15 times in eight years. That amounts to an average of roughly twice a year when winds are known to cause at least some damage.

Exposure

Though the entire region is subject to high winds, Carroll County and the City of Galax appear to be hit the most often. Given the regionalized nature of the available data, it is not possible to quantify what a typical wind incident might consist of and how much cost it may create for the community or to private individuals.

Consequences

Damage estimates through the National Climatic Data Center are reported by incident rather than by locality, unless the damages are confined to a small geographic area. Based on the reported incidents, damages may range from zero to up to more than $400,000 (see incident of Jan. 10, 2001 in Table No. 32).

The reported damages include downed trees, tree limbs and power lines; shingles, siding and roofs torn away from homes; damage and uprooting of mobile homes; tractor-trailers blown over and sometimes lifted off the highway, particularly near the Fancy Gap area of Interstate 77; and loss of electrical power. High wind events, while they occur frequently, appear to cause only scattered property damage. This hazard does not appear to pose a disaster-level hazard to the Mount Rogers region as a whole, although some localities regularly sustain high winds.[107]

[107] See Section 4: Hazard Mitigations and the localized mitigation recommendations for communities such as Carroll County, Grayson County, and the City of Galax.

HAZARD RISK ASSESSMENTS: CONCLUSIONS

Hazard Risk Matrix

The risk assessment analysis has been used to create the Hazard Risk Matrix shown below to provide a guideline on the relative importance of natural hazards across the entire Mount Rogers region. The rankings for individual localities will differ from the regional matrix due to differences in terrain, impacts from flooding, potential for wildfire, and so on.

The criteria and format for the matrix, in Table No. 33, is adapted from the Hyde County, N.C. Multi-Hazard Mitigation Plan.[108] There are various ways to create a matrix; this one was appealing due to its simplicity and ease of application. The matrix is intended as a guideline and is based on the best information available. In some instances there is very little supporting data, so numerical scores have been assigned based on educated guesswork.

Table No. 33: HAZARD RISK MATRIX
Mount Rogers Region, Virginia

Hazard	Frequency	Geographic Extent	Impact	Hazard Risk Index Rating
Dam Safety	3	1	3	7
Drought	2	4	1	7
Earthquakes	2	2	1	5
Flooding	4	2	3	9
Karst and Sinkholes	2	1	1	4
Landslides	1	1	2	4
Snow/Ice	4	4	1	9
Thunderstorms/Lightning	4	1	1	6
Tornadoes/Hurricanes	4	1	1	6
Wildfires	4	1	2	7
Winds	4	2	1	7

Note: Highest numbers mean highest risk or impact.

The **frequency column** is based on likelihood of occurrence:

4 = More than once in 10 years
3 = More than once in 10-100 years
2 = More than once in 100-1,000 years
1 = Less than once in 1,000 years

The **geographic extent column** relates to the extent any given hazard affects the jurisdiction:

4 = More than 50% of jurisdiction affected
3 = Estimated 25-50% of jurisdiction affected
2 = Estimated 10-25% of jurisdiction affected
1 = Less than 10% of jurisdiction affected

[108] The Hyde County, N.C. hazard mitigation plan was published in September 2002.

The **impact column** relates to the amount of death, injury, destruction and inconvenience created for the affected area, as shown below:

4 = Many deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.
3 = Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities more than one week.
2 = Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities more than one day.
1 = Very few injuries, if any. Only minor property damage and minimal disruption of quality of life. Temporary shutdown of critical facilities.

Natural hazards on a regional basis can then be ranked as shown in Table No. 34, below. As already noted, there will be some variances for some localities.

Table No. 34: HAZARD RISK CATEGORIES
Mount Rogers Region, Virginia

High Risk Hazards (score 8 or higher) ➡	**Flooding** **Severe Winter Storms/Ice**
Moderate Risk Hazards (score of 7) ➡	**Dam Safety** **Drought** **Wildfires** **Winds**
Low Risk Hazards (score of 6 or less) ➡	**Earthquakes** **Karst and Sinkholes** **Landslides** **Thunderstorms/Lightning** **Tornadoes/Hurricanes**

Hazard Risk Assessment By Jurisdiction

The main natural hazards faced by the 20 local jurisdictions in the Mount Rogers region are displayed in the matrix shown below (Table No. 35). This data has been drawn from the descriptions given in the preceding pages of this section. This matrix is designed to meet FEMA requirements for the Pre-Disaster Hazard Mitigation reports.

Table No. 35: Identified Natural Hazards, By Locality
Mount Rogers Region, Virginia (6 counties, 2 cities, and 12 towns)

Hazard Type	Hazards Identified	Individual Localities																			
		Bland County	Carroll County	Grayson County	Smyth County	Wash. County	Wythe County	City Bristol	City Galax	Abingdon	Chilhowie	Damascus	Fries	Glade Spring	Hillsville	Independence	Marion	Rural Retreat	Saltville	Troutdale	Wytheville
Avalanche																					
Coastal Erosion																					
Coastal Storm																					
Dam Safety	X	X	X	X	X	X	X	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Drought	X	M	M	M	M	M	M	L	L	L	L	X	X	X	X	X	L	L	L	L	L
Earthquake	X	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Expansive Soils																					
Extreme Heat																					
Flood	X	H	L	H	H	H	H	H	H	H	H	H	na	H	na	L	H	L	H	na	H
Hailstorm																					
Hurricane (see Tornadoes)																					
Karst and Sinkholes	X	X	na	na	X	X	X	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Landslide	X	L	H	H	H	H	L	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Severe Winter Storm/Ice	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Tornadoes/Hurricanes	X	L	L	L	M	M	L	L	L	na	na	na	na	na	na	na	na	na	na	na	na
Tsunami																					
Volcano																					
Wildfire	X	M	H	M	H	H	na	na	M	na	na	na	na	na	na	na	na	na	na	na	na
Windstorm	X	M	H	M	M	M	M	M	H	M	M	M	M	M	H	M	M	M	M	M	M
Thunderstorms/Lightning	X	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Notes:
The term "na" means the hazard data is not available.
The H, M, and L symbols refer to the relative likelihood and/or relative severity of given hazards, comparing one locality to another. H = highest likelihood, M = moderate likelihood, and L = low likelihood. X indicates the hazard was identified, but further hazard assessment data was lacking.

Hazard Mitigations

Section 4

Defining Hazard Mitigation

FEMA defines hazard mitigation as "sustained actions taken to reduce or eliminate long-term risk from hazards and their effects."[109]

These sustained actions can come in the form of physical projects (enlargement of drainage culverts, streambank stabilization and restoration, vegetation removal, installation of advance warning systems, etc.) or educational programs designed to help local officials and property owners understand and reduce hazard risk (media campaigns, special mailings, special events, self-help guides, etc.).

For some hazards, these actions could involve simply getting out of the way – such as not building in the floodplain or removing structures from the floodplain, when feasible. For other hazards, such as major weather events that cover large areas of landscape, the mitigations could involve more indirect methods, such as improved building codes to strengthen structures and reduce damages from violent windstorms or major blizzards. Some hazards – such as an F4 or F5 tornado – carry such force that a direct hit means destruction is assured, although properly built "safe rooms" can reduce loss of life.

In the previous section of this study, we have identified and ranked the main natural hazards that can afflict communities in the Mount Rogers region of southwest Virginia. We are now moving on in this next section to describe the following:

- Planning process used to develop the hazard mitigation strategy.
- Goals and objectives for the overall hazard mitigation strategy for the region.
- Recommended hazard mitigations on a locality-by-locality basis.

Process Used to Develop Mitigation Strategy

MRPDC staff, the Hazard Mitigation Advisory Team, and representatives from the local jurisdictions worked together to develop the Hazard Mitigation Strategy for the Mount Rogers region.

Following the guidance found in the FEMA how-to guides for hazard mitigation, MRPDC staff identified the high-risk and moderate-risk hazards that affect the region and its 20 local jurisdictions. This was done based on available data. With the basic data assembled, the MRPDC organized a Hazard Mitigation Advisory Team[110] to review and make comments on the hazard vulnerability assessments. Some of the recommended mitigations emerged from those discussions, such as a suggestion by a representative from American Electric Power to work to improve coordination among emergency response organizations to improve snow-removal and accelerate restoration of electric power following major snow and ice storms. In addition, the

[109] From glossary section of *Understanding Your Risks: Identifying Hazards and Estimating Losses*, FEMA state and local mitigation how-to guide. August 2001.
[110] See appendices for a listing of the Hazard Advisory Team members and their affiliations.

MRPDC mailed out draft copies of the hazard vulnerability assessments to the 20 local jurisdictions and invited comments.

MRPDC staff moved on to develop the specifics for both the Hazard Mitigation Strategy and proposed mitigations. In some cases we have followed the advice of experts, such as the applications of Firewise methods to reduce wildfire risks. In other cases we have proposed mitigation strategies based on limitations of the available data and on long-understood shortcomings, such as the lack of accurate floodplain mapping (as determined by hydrological engineering studies) and the lack of floodplain mapping in some areas known to be flood-prone but passed over by previous mapping efforts.

For flood hazards, which affect much of the population of the Mount Rogers region, MRPDC staff applied the principles of FRED (i.e., Fix and Repair, Elevate, Relocate or Demolish). Staff developed generalized cost estimates based on the experience of a consultant who most recently worked in flood mitigation in north Georgia and previously worked with the Tennessee Valley Authority. For more details on how cost estimates were arrived at, please see the appendices section.

All participants in the process have always recognized that any major undertakings will only be possible with outside funding support (i.e., state and federal grants), since localities in the Mount Rogers region are sparsely populated, sparsely staffed, and lack the financial means to provide little other than basic government programs and services.

Regional Hazard Mitigation Strategy

The following outline consists of goals and objections for the natural hazard mitigation strategy to be applied in the Mount Rogers region of Virginia.

Mission Statement: Protect lives and property from damage and/or destruction due to natural hazards.

Goal: Protect Lives and Property from Flooding
Objective: Increase Public Awareness
Strategy:
--Promote and make the public aware of the need for mitigation
--Promote planning as well as membership in the National Flood Insurance Program
Objective: Improve data resources to improve the regional Hazard Mitigation opportunities.
Strategy:
--Update FEMA flood plain maps throughout the Mount Rogers region.
--Develop new FEMA floodplain maps not previously mapped.

Objective: Provide opportunities for property owners of flood prone and/or repetitive loss properties to relocate from the flood plain, elevate structures, or flood proof their property.

Strategy:

--Pursue funding for such projects from federal and state agencies such as FEMA, VDEM, as well community development block grants.

Cost Benefit: The benefits of flood protection are ongoing. Money should be invested wisely to protect existing structures, as well as to prevent future loses to new structures. This will be a savings to the localities, as well as to the property owners in the form of repair and insurance cost. $100,000 spent today, could save millions of dollars in damage over long periods of time, as well as save lives.

Responsible Office: MRPDC \ local Board of Supervisors \ VA Tech \ Local Emergency Management

Goal: Encourage Public Safety in the Event of Snowstorms/Ice and High Winds
Objective: Increase public awareness of actions before, during, and after such events.
Strategy:

--Educate public on the methods recommended by the American Red Cross to prepare for these events.

--Inform motorist of high wind potential along selected highways.

Cost Benefit: Public awareness is crucial to prevent losses due to natural hazards. Not only prevention, but a large savings of time and money could be seen during and after such adverse weather. $100,000-$500,000 spent on increased road advisories will save money on working traffic accidents, as well as work hours lost in Traffic.

Responsible Office: VDOT \ Local Board of Supervisors \ Red Cross

Goal: Increase Dan Safety for the Mount Rogers Region
Strategy:

--Improve the availability of data resources for dam safety to save lives and property coordinated through agencies such as FEMA and the Department of Conservation and Recreation.

Cost Benefit: Knowledge and being aware of potential hazards plays a key role in their prevention. Due to many recent events, information on dams in the region is hard to come by. Property owners in a high risk area could benefit from greater knowledge of possible dangers. For a minimal cost, this could save property as well as lives.

Responsible Office: Department of Conservation and Recreation; Corps of Engineers

Goal: Minimize the Impact of Wildfires on Woodland Communities.
Objective: Increase public awareness.
Strategy:

--Educate homeowners on Firewise and Department of Forestry programs on methods to cope with drought.
--Support and encourage the existing education efforts of the American Red Cross in ways homeowners can reduce the risk of wildfires by property maintenance and cleanup.

Cost Benefit: Education is invaluable to prevent Wildfires. For a minimal cost, educational programs for homeowners in woodland communities will help minimize fire damage to property, and natural resources.

Responsible Office: USDA; VA Dept. of Forestry; FireWise, Local Fire and Rescue

Goal: Encourage Citizens to Prepare for Possible Damage from Sinkholes and Karst
Objective: Increase public awareness
Strategy:
--Make sure local building codes and zoning ordinances address placement of structures in such areas.
--Educate the public on karst safety through educational efforts such as agencies like the Virginia Cave Board.
--Map areas that are in danger of karst and sinkholes with the state division of mineral resources, and the Virginia Cave Board.

Cost Benefit: Having and making available good data where land is susceptible to karst and sinkholes can pay dividends in the future. Accurate mapping of such areas made available to local officials can greatly reduce the risk of structures and roads being damaged by these hazards.

Responsible Office: Local Building inspector; VDOT, Department of Conservation and Recreation

Goal: Minimize Damage due to Thunderstorms as well as Tornadoes/Hurricanes
Strategy:
--Support and encourage existing efforts by the American Red Cross to educate homeowners on retrofitting and mitigation.
--Educate citizens on tornado and severe storm safety.

Cost Benefit: Public awareness is crucial to prevent losses due to natural hazards. Not only prevention, but a large savings of time and money could be seen during and after such adverse weather.

Responsible Office: Local emergency management departments

Regional Strategic Priorities

This section outlines the top regional priorities for Pre-Disaster Hazard Mitigation in the Mount Rogers region. These have been determined through discussions among MRPDC staff and the members of the Hazard Mitigation Advisory Team.

The priorities presented in this section correspond to the objectives listed under the six goal statements given for the regional strategic plan described above. MRPDC staff initially developed the goals-and-objectives outline, and then presented it to the Hazard Mitigation Advisory Team for comment.

The Advisory Team ranked individual objectives by assigning adhesive markers to the five objectives considered most important by each individual. Each member was told to assign three markers to top priorities, two markers to mid-level priorities, and one marker to the lowest priorities. More than one objective could be assigned to any given priority level. Each marker carried a value of one point, with the highest point scores indicating the objectives of highest importance. The results and point totals appear in Table No. 36.

Table No. 36: Prioritized Listing of Hazard Mitigation Objectives
Mount Rogers Region, Virginia

Objective	Points
Promote need for pre-disaster mitigation to prevent future losses.	12
Update FEMA floodplain maps as applicable throughout the Mount Rogers Region.	12
Promote prevention methods homeowners can undertake.	12
Implement in-the-ground projects to reduce natural hazard risks.	9
Provide copies of the Pre-Disaster Hazard Mitigation Plan to the 20 local jurisdictions in the Mount Rogers region.	8
Support projects offering the best benefit/cost ratio.	6
Publicize successful mitigation projects.	5
Support guidelines for flood mitigation: ▪ A property is a candidate for relocation if the first floor floods twice (or more) in 50 years. ▪ A property is a candidate for elevation or flood-proofing if flooding occurs below the first floor twice (or more) in 50 years. ▪ Meet requirements of the Uniform Relocation Act. ▪ The top priorities for federal relocation assistance should be based on need, frequency of flooding, and a favorable benefit/cost ratio.	5
Create project serving multiple objectives (social, community, economic, mitigation).	4
Support educational efforts of existing organizations, such as the American Red Cross.	4
Develop new FEMA floodplain maps for flood-prone areas not previously mapped.	3
Promote useful programs, such as the National Flood Insurance Program.	1

Support state/federal efforts to improve data resources for dam safety, drought, karst and sinkholes, landslides, thunderstorms, and windstorms.	0
Post Mount Rogers Pre-Disaster Hazard Mitigation Plan to the MRPDC website.	0

Note: This prioritized listing is a product of the Oct. 20, 2004 meeting of the Hazard Mitigation Advisory Team.

Development of the prioritized listing for the regional hazard mitigation objectives created much discussion among members of the Hazard Mitigation Advisory Team[111]. The comments raised by the team included the following:

- There was skepticism whether local building code employees enforce the law fully and fairly, without succumbing to local political pressures. Others replied there has been much progress in this area, especially in the past 10 years or so, and that the local codes personnel are doing a good job.
- Team members questioned the meaning of the Uniform Relocation Act and its provisions that cover the costs of moving for flood victims. Some members wondered whether flood victims would in fact "do the right thing" and agree to move out of the floodplain. MRPDC staff explained the business of relocation is complicated and difficult; the Uniform Relocation Act at least provides extra help to those, such as the poor and the elderly, who lack resources to relocate out of the floodplain.
- Some team members felt objectives to "promote" given initiatives should be stated in stronger terms, to add teeth to the Hazard Mitigation Plan. MRPDC staff explained the enforcement derives from new federal regulations[112], building code regulation, and banks and insurance companies that increasingly require flood insurance as a condition of granting mortgages.
- Team members observed the Hazard Mitigation Strategy should include low-impact development, rain gardens, and other "green" approaches to help mitigate flooding.
- The team felt there had been much discussion of flood mitigation, but very little discussion on mitigating for winter storms/ice and for high winds, both of which are important issues, especially for Grayson and Carroll counties and the City of Galax. The team agreed snowstorm mitigation mainly relates to sufficient manpower, equipment, and logistical coordination; these issues, in turn, depend upon an effective Emergency Operations Center.
- The team supported adding recommendations calling for better advance preparation on the local level and for the development and use of updated Emergency Operations Plans. The EOPs, while required for all counties, do not always work well when communities are hit by major weather events or other large-scale emergencies. These are times when effective coordination count the most, team members said.

[111] Also, see comments contained in Table No. 3, detailing the public input process for this Plan.
[112] These include the Disaster Mitigation Act of 2000, which requires localities to develop pre-disaster hazard mitigation plans in order to qualify for federal disaster assistance.

Recommended Hazard Mitigations by Jurisdiction

The following section provides descriptions, by jurisdiction, of high- and moderate-risk natural hazards, past or ongoing mitigations (if any), and recommended mitigations resulting from this study. The section is organized in alphabetical order by county and the towns contained within that county, followed by the cities. This includes:

- Bland County
- Carroll County and the Town of Hillsville
- Grayson County and the towns of Fries, Independence, and Troutdale
- Smyth County and the towns of Chilhowie, Marion, and Saltville
- Washington County and the towns of Abingdon, Damascus, and Glade Spring
- Wythe County and the towns of Rural Retreat and Wytheville
- The City of Bristol
- The City of Galax.

This section concludes with an accounting of lessons learned from undertaking this study for the Mount Rogers Planning District Region of Virginia.

Bland County

Community Hazard Profile

Bland County is a rural, lightly populated community of nearly 7,000 with Interstate 77 bisecting the county as the highway travels in a north-south direction. There are no incorporated towns, though county administrative functions are centered in the community of Bland, located at the junction of I-77 and State Rt. 42. The Appalachian Trail crosses through parts of the county.

The main natural hazards faced in Bland County are flooding, severe snow and ice storms, wildfire, and potential dam failure. Due to its mountainous terrain, communities are subject to flash flooding caused by heavy rainfalls and snowmelt; this is especially true for Rocky Gap, a small, unincorporated community located almost entirely in the floodplain. Bland County also experiences its share of high-wind conditions, though these have not been known to create natural disasters.

In January 1957, the community of Bland sustained substantial damage from a failure in the Crab Orchard Creek Dam, which had been under development as a privately owned recreation attraction. The dam break occurred following three days and nights of continuous rain, and the resulting flood caused $500,000 worth of damage to the small community. There is now some thought that, with construction of I-77 (which passes between the dam and the community), a similar event would not happen again, since I-77 and its drainage systems would redirect the flood flows.

Past or Ongoing Mitigations

Bland County centralizes its emergency response system through its E-911 and emergency services coordinator (one individual). Emergency responders include a system of local volunteer fire departments and rescue squads, as well as the sheriff's department and state police. The county's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[113]

Bland County has not engaged in pre-disaster mitigation efforts in the past.

For flood hazards, Bland County contains five repetitive loss properties, including three in the community of Rocky Gap. One of the properties has sustained flood losses five times and has collected nearly $17,000 in loss payments.

[113] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Recommended Mitigations: Bland County

Table No. 37: Bland County and Localities Mitigations

Rank	Activity	Hazard Addressed
High	Conduct hydrological/engineering studies to properly determine Base Flood Elevations in those watersheds with estimated floodplains.	Floods
High	Conduct detailed studies to determine the most cost-effective mitigations for communities with flooding issues, which include Bland, Bastian, and Rocky Gap.	Floods
High	Use the flood analysis in the appendices section as a basis for consideration of future relocation/demolition and flood-proofing projects.	Floods
High	Mitigate against future flood losses, with highest priority given to repetitive loss properties.	Floods
Medium	Promote the Firewise program for people who live in woodland communities. An estimated 265 homes fall into this category in various parts of Bland County.	Wildfire
Medium	Work with the New River-Highlands RC&D Council a wildfire strategic plan for Bland County.	Wildfire
Low	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Low	Continue inspection and enforcement as necessary on the Crab Orchard Creek Dam, rated Class I for hazard potential.	Dam Safety

Carroll County and Hillsville

Community Hazard Profile

Carroll County abuts the northern border of North Carolina and includes a section of the Blue Ridge Parkway and the New River Trail State Park. A community of 29,245, the county includes the incorporated Town of Hillsville, which serves as the county seat, and abuts the City of Galax to the west. Elevations vary from 3,570 feet above sea level at Fisher Peak to 1,100 feet above sea level at Cana. The county also is notable for the Blue Ridge Escarpment (steep slope) that separates the piedmont of North Carolina from the Blue Ridge Plateau. More than half of the land area has slopes greater than 20%, which precludes most development.

Carroll County is bisected by Interstate 77 in a north-south direction and by U.S. Rt. 58 in an east-west direction. The county is known for high wind conditions at Fancy Gap, where tractor trailers sometimes get blown over or even lifted away from the highway altogether and dumped into a field some distance away. Carroll County is part of a Special Wind Region, with potential wind speeds up to 200 mph.

Other natural hazards experienced in Carroll County include severe winter storms and ice, wildfires, drought, and undefined risk potential for landslides and impacts from karst terrain. Flood hazards are limited (one repetitive loss property in or near Hillsville). There are two federally regulated hydroelectric dams and one state-regulated dam in Carroll County.

Past or Ongoing Mitigations

A special project by the New River-Highlands RC&D Council has produced a draft strategic plan for wildfire hazard reduction in Carroll County. For emergency response the area is served by the Twin County E-911 system, volunteer fire departments and rescue squads, and the sheriff's department and state police. The county Board of Supervisors has recently hired an emergency services coordinator to help improve the emergency response system.

VDOT has been in the process of installing a warning system to help truckers get off I-77 and find alternate routes during high-wind conditions and other potentially dangerous conditions, such as fog, another ongoing problem in the Fancy Gap area. Members of the Hazard Mitigation Advisory Team have said the warning system has limited usefulness since there are few exits from the highway.

The county's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[114]

[114] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Recommended Mitigations: Carroll County and Hillsville

Table No. 38: Carroll County and Localities Mitigations

Rank	Activity	Hazard Addressed
High	Promote the Firewise program for people who live in woodland communities. An estimated 712 homes fall into this category in various parts of Carroll County. This represents one of the worst natural hazard threats in the region.	Wildfire
High	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Medium	Support improved highway warning systems for truckers on I-77 facing high-wind conditions in the Fancy Gap area.	Winds
Low	Consider flood-proofing or relocation/demolition for the repetitive loss property near Hillsville.	Floods
Low	Properly inspect and enforce applicable state and federal dam regulations for high- and significant-hazard dams.	Dam Safety

Grayson County and Fries, Independence and Troutdale

Community Hazard Profile

Grayson County is a remote, rural area with a population of 17,100. The county is traversed east-west by U.S. Rt. 58, north-south by State Rt. 16 (passing through the Town of Troutdale), and north-south by U.S. Rt. 21 (passing through the Town of Independence). The three incorporated towns include Fries, Independence, and Troutdale. Parts of the county abut the independent City of Galax at the county's eastern border. Grayson's mountainous terrain includes Grayson Highlands State Park in the western end and parts of the Mount Rogers National Recreation Area running roughly along the county's northern border.

Chief natural hazards occurring in Grayson County include flooding, severe snow and ice storms, high winds, and risk of wildfire. Flooding affects relatively few properties, and there is no FEMA record of repetitive loss properties. Substantial parts of Grayson, encompassing roughly 60,000 acres, are subject to wildfire risk. Grayson also contains four dams rated for significant hazard potential and has an undefined risk of potential for landslides, especially in the northern part of the county.

Past or Ongoing Mitigations

A special project by the New River-Highlands RC&D Council has produced a draft strategic plan for wildfire hazard reduction in Grayson County. The emergency services system includes the Twin County E-911 center, several volunteer fire departments and rescue squads, the sheriff's department and the state police.

VDOT has been in the process of installing a warning system to help truckers get off I-77 and find alternate routes during high-wind conditions and other potentially dangerous conditions, such as fog, another ongoing problem in the Fancy Gap area. Members of the Hazard Mitigation Advisory Team have said the warning system has limited usefulness since there are few exits from the highway.

The county's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[115]

Grayson County has not participated in the pre-disaster hazard mitigation projects in the past, other than what has already been noted. Like the other localities in the Mount Rogers region, most hazard mitigation efforts are not possible without substantial outside support from state and federal grants.

[115] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Recommended Mitigations: Grayson County and Fries, Independence, and Troutdale

Table No. 39: Grayson County and Localities Mitigations

Rank	Activity	Hazard Addressed
High	Support implementation of the strategic plan for wildfire hazard reduction in Grayson County.	Wildfire
High	Support educational programs to promote Firewise methods to affected residents of woodland communities. An estimated 258 homes are part of woodland communities in Grayson County.	Wildfire
High	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Medium	Support improved highway warning systems for truckers on I-77 facing high-wind conditions in the Fancy Gap area.	Winds
Medium	Conduct hydrological/engineering studies to properly determine Base Flood Elevations in those watersheds with estimated floodplains.	Floods
Medium	Conduct hydrological/engineering studies to determine Base Flood Elevations within the Town of Troutdale, which presently lacks a recognized floodplain.	Floods
Medium	Conduct hydrological/engineering studies to determine Base Flood Elevations within the Towns of Fries and Independence.	Floods
Low	Properly inspect and enforce applicable state and federal dam regulations for high- and significant-hazard dams.	Dam Safety

Smyth County and Chilhowie, Marion, and Saltville

Community Hazard Profile

Smyth County, with a population of 33,000, stands along the east-west path of I-81, north – south path of Rt. 16, and also is part of the Mount Rogers National Recreation Area. Population growth is stagnant, due in part to loss of the traditional industrial base and limited housing development. Despite those drawbacks, the county is traversed by the Appalachian Trail, offers appealing country vistas, and stands within easy reach of many natural resource attractions.

The main natural hazards affecting Smyth County include flooding along the North, Middle, and South Forks of the Holston River, as well as several tributaries; severe winter storms and ice; some potential for dam failure; drought; and undetermined risk from landslides and karst terrain, which appears in an estimated 30% of the county's territory. The county also is part of a Special Wind Region (with wind speed potential of 200 mph), but this problem rarely causes enough damage to be considered a major hazard.

Past or Ongoing Mitigations

Due to its long history with disaster-level flooding, Smyth County and its communities have participated in special flood mitigation projects. Record-level disasters resulting from the floods of 1977 led to a flood mitigation engineering study for the towns of Chilhowie and Marion, as well as the nearby communities of Atkins and Seven Mile Ford. In Chilhowie the work resulted in the eventual relocation of 67 families and the creation of the Chilhowie Recreation Park.[116] Other recommended flood mitigations have not been pursued due to lack of funding and/or a sense, especially among local industries, that they would rather risk another flood as opposed to investing in flood mitigations.

Smyth County also, as a result of flooding in 2001 and 2002, obtained federal disaster relief funds and relocated five homes out of the floodplain in River Bottom Circle, located near the Broadford community along the North Fork of the Holston River.

More recently the Town of Chilhowie participated in a preliminary flood reduction study by the U.S. Army Corps of Engineers. About 12-15 properties continue to sustain flood damage within town borders. The town has opted against pursuing a more detailed study due to the high cost and instead is advocating for mitigating the most flood-prone structures in the town.

Emergency response is coordinated through Smyth County's centralized E-911 system. The county also is in the beginning stages of creating a modernized countywide communications system for emergency response and direct radio communications among police, fire departments, and rescue squad organizations. The Marion Life Saving Crew, while essentially a volunteer

[116] Relocation of the families and demolition of the homes created open space that still floods, but losses in that area are limited to items such as picnic tables.

organization, has in recent years begun charging for its services when feasible (through private health insurance) to cover the costs for paid daytime emergency responders.

The county's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[117]

Recommended Mitigations: Smyth County and Chilhowie, Marion, and Saltville

Table No. 40: Smyth County and Localities Mitigations

Rank	Activity	Hazard Addressed
High	Mitigate against future flood losses, with highest priority given to the five repetitive loss properties (two in the Town of Chilhowie, one in the Town of Marion, and two in the Town of Saltville).	Floods
High	Conduct hydrological/engineering studies to determine Base Flood Elevations in watersheds containing estimated floodplains.	Floods
High	Encourage more participation by property owners in the National Flood Insurance Program.	Floods
High	Use the flood analysis in the appendices section as a basis for consideration of future relocation/demolition and flood-proofing projects.	Floods
High	Support the continued development of the improved countywide radio communications system to improve emergency response and coordination during major disasters and other emergencies.	All
Medium	Support educational programs to promote Firewise methods to affected residents of woodland communities. An estimated 475 homes are located in wooded settings and subject to risk of wildfire.	Wildfire
Low	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Low	Properly inspect and enforce applicable state and federal dam regulations for high- and significant-hazard dams. Presently Hungry Mother Dam is regulated as a high-risk potential dam in the county.	Dam Safety

[117] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Washington County and Abingdon, Damascus, and Glade Spring

Community Hazard Profile

Washington County is a rapidly developing area located on the west end of the Mount Rogers region and is bisected by Interstate 81 in an east-west direction. Within the past decade the most change and growth has been occurring along the I-81 corridor between the Town of Abingdon and the City of Bristol, with much housing development, as well as burgeoning commercial development at the Exit 7 area. Former communities consisting largely of open space and farming are being converted into residential subdivisions to accommodate the growing population of more than 51,000.

The chief natural hazards of concern to Washington County and its localities include flooding, wildfires, severe winter storms and ice, drought, undetermined risk for impacts from landslides and karst terrain (which occurs in 50% of the county's territory), and high winds.

The flooding results from sustained heavy rainfalls, violent thunderstorms, or as the aftermath of a major snowstorm. FEMA records show three repetitive loss properties (Mendota community, Abingdon and near Bristol). Wildfire risks derive from being located in a rural, forested region and development of woodland home communities (encompassing more than 100,000 acres in the county). Severe winter storms and/or ice have been known to lead to disaster declarations, while drought is only an occasional hazard with impacts mainly for the farming community.

Washington County also contains four dams rated for high- or significant-hazard in the event of failure. Two are flood control structures owned by the Tennessee Valley Authority and one is a hydroelectric dam that has been breached and is no longer active. A fourth dam, owned by the state Department of Game and Inland Fisheries, is a recreational area regulated by the state.

Past or Ongoing Mitigations

Washington County operates its own E-911 system for emergency response from among an array of volunteer fire departments and rescue squads, the sheriff's department and the state police.

A long history of disaster-level flooding led to a comprehensive flood mitigation study for the Town of Damascus completed in 1979. In time, with support from outside grant funding, the town relocated 34 families (88 people) and three local businesses out of the floodplain. The town also was able to install storm drainage systems along flood-prone areas in Mock, Surber, and Haney Hollows. Damascus continues to face a serious flood threat due to its location at the confluence of Beaverdam and Laurel creeks and the lack of developable land outside of the floodplain.

As with the flood mitigation studies done for Smyth County, Damascus could not afford the high cost of the comprehensive approach. In addition, some mitigations considered in the 1970s and 1980s – including stream channelization and installation of levees – would not be allowed under modern state and federal regulations.

The Town of Abingdon has recently updated its floodplain maps but has not been involved in mitigation efforts such as elevations or relocations and demolitions. The Town of Glade Spring has obtained funding to install upstream and downstream storm detention reservoirs as part of a downtown revitalization effort.

The county's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[118]

Recommended Mitigations: Washington County and Abingdon, Damascus, and Glade Spring

Table No. 41: Washington County and Localities Mitigations

Rank	Activity	Hazard Addressed
High	Conduct hydrological/engineering studies to determine Base Flood Elevations in watersheds containing estimated floodplains.	Floods
High	Encourage more property owners to insure their homes through the National Flood Insurance Program.	Floods
High	Consider appropriate mitigation projects for the three repetitive loss properties identified by FEMA data.	Floods
High	Conduct hydrological/engineering studies to determine Base Flood Elevations and create a new floodplain map for Cedar Creek in the Meadowview community.	Floods
High	Use the flood analysis in the appendices section as a basis for consideration of future relocation/demolition and flood-proofing projects.	Floods
High	Support educational programs to promote Firewise methods to affected residents of woodland communities. An estimated 804 homes are located in wooded settings and subject to risk of wildfire.	Wildfire
Medium	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Low	Properly inspect and enforce applicable state and federal dam regulations for high- and significant-hazard dams. There are four such dams in Washington County, one of which has been breached.	Dam Safety

[118] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Wythe County and
Rural Retreat and Wytheville

Community Hazard Profile

Wythe County is a community of 27,600 that is traversed north-south by Interstate 77 and east-west by Interstate 81, as well as routs 21, 52, and 94. The county includes the incorporated towns of Rural Retreat and Wytheville, which serves as the county seat. The county caters to the trucking industry and also recently facilitated the construction of a major new Pepsi bottling plant along the I-81 corridor. More than 50% of the county contains slopes of more than 20%, which hinders development in those steep areas.

Chief natural hazards experienced in Wythe County and its localities include flooding, severe winter storms and ice, high winds, drought, and undetermined hazards from karst terrain (which appears in roughly 30% of the county's landscape). There is one high-hazard potential dam (Rural Retreat Dam) owned as a recreational attraction by the Virginia Department of Game and Inland Fisheries.

The flooding results from sustained heavy rainfalls, violent thunderstorms, and melting as the aftermath of a major snowstorm. Flood hazards have been identified for the Town of Wytheville and the community of Max Meadows east of Wytheville. There is only one repetitive loss property in Max Meadows.

Past or Ongoing Mitigations

Emergency response is based around the county's E-911 system, the sheriff's department, the state police, and several volunteer fire departments and rescue squads.

The county's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[119] These modern codes help protect against hazard damages, such as those from high winds.

[119] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Recommended Mitigations: Wythe County and Rural Retreat and Wytheville

Table No. 42: Wythe County and Localities Mitigations

Rank	Activity	Hazard Addressed
High	Conduct hydrological/engineering studies to determine Base Flood Elevations in watersheds containing estimated floodplains.	Floods
High	Encourage more property owners to insure their homes through the National Flood Insurance Program.	Floods
High	Use the flood analysis in the appendices section as a basis for consideration of future relocation/demolition and flood-proofing projects.	Floods
Medium	Support development of strategic wildfire risk reduction plans such as being promoted by the New River-Highlands RC&D Council.	Wildfire
Medium	Support educational programs to promote Firewise methods to affected residents of woodland communities. An estimated 20,000 acres of land (unknown number of woodland homes) are subject to wildfire risk in Wythe County.	Wildfire
Low	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Low	Properly inspect and enforce applicable state and federal dam regulations for high- and significant-hazard dams. Rural Retreat Dam falls into the high-hazard potential category in Wythe County.	Dam Safety

City of Bristol

Community Hazard Profile

The City of Bristol, Virginia is a community of 17,300 located along Interstate 81 and abutting the far southwestern reach of Washington County. Though it declined in population from 1990 to 2000, the city has experienced some transition in some old residential areas being converted to commercial uses and some shift toward high-tech industry. Bristol stands in the lowlands of the Valley and Ridge physiographic province, and this area is characterized by karst terrain.

Chief natural hazards experienced in the City of Bristol include flooding, which causes estimated annual damages of $3.9 million, according to a recent study by the U.S. Army Corps of Engineers. Other natural hazards faced in Bristol include severe winter storms and ice, high winds, and undetermined hazard risks from karst terrain and landslides. Two high-hazard potential dams affecting Bristol include Clear Creek Dam and Beaver Creek Dam, both located upstream in Washington County.

Past or Ongoing Mitigations

The City of Bristol, Virginia teamed up with the City of Bristol, Tennessee to work with the U.S. Army Corps of Engineers to conduct the "Flood Damage Reduction Feasibility Study" of 2003 to identify ways to reduce continuing flood damage, especially along the main stem of Beaver Creek, which passes through the center of the adjacent cities. The Corps of Engineers recommended the following flood mitigations in July 2003:

- Widening the Beaver Creek channel near 6th Street (in Bristol, Tenn).
- Replacing a pedestrian bridge and removing the 8th Street Bridge (in Bristol, Tenn.)
- Removing the old Sears commercial building near State Street (in Bristol, Tenn.)
- Replacing the existing outlet structure (a 48-inch diameter pipe) on Beaver Creek Dam with a larger reinforced concrete structure to more effectively hold back flood flows.

The Corps of Engineers estimated the proposed mitigations will reduce total average annual flood damages by 20% and reduce flood levels by nearly one foot in the central business districts of both Bristol, Virginia and Bristol, Tennessee.[120]

The city's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[121] These modern building codes help offset damages caused by natural hazards, such as high winds, for new construction.

[120] From "Flood Damage Reduction Feasibility Study," by U.S. Army Corps of Engineers, page 48. July 2003.
[121] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Recommended Mitigations: City of Bristol

Table No. 43: City of Bristol, Virginia Mitigations

Rank	Activity	Hazard Addressed
High	Support implementation of the remedies outlined by the U.S. Army Corps of Engineers in July 2003 for the cities of Bristol in Virginia and Tennessee.	Floods
Medium	Support educational programs to promote Firewise methods, as appropriate to residents of woodland communities. More specific data for the city was not available at the time this report was written.	Wildfire
Low	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Low	Properly inspect and enforce applicable state and federal dam regulations for high- and significant-hazard dams. These include Clear Creek Dam and Beaver Creek Dam.	Dam Safety

City of Galax

Community Hazard Profile

The City of Galax, a community of 6,800, is located in a hilly area with above-sea elevations ranging from 2,340 feet to 2,980 feet at Ward Knob.

While the City of Galax contains a defined floodplain along Chestnut Creek, which flows north-south through the city core, Galax does not participate in the National Flood Insurance Program and has resisted suggestions it rejoin the program, despite disaster-level flooding in November 2003 and repeat flooding problems in 2004. For communities that refuse to participate in NFIP, disaster help from FEMA is not available in the defined floodplains.[122] Flooding problems also have been evident recently along the tributary of Mill Creek, which is not part of a recognized FEMA floodplain. Flooding on the tributaries occurs because the city's storm drainage system is aging (50 years old), with parts of the piping collapsing; these problems block storm water drainage and worsen flooding problems in some residential neighborhoods.

Other natural hazards faced by the City of Galax include wildfires and high winds. The city, along with much of the Mount Rogers region, is part of a Special Wind Zone (winds up to 200 mph), although the problems created do not appear to be of disaster level and the city does enforce current building codes.

Past or Ongoing Mitigations

The City of Galax grew up around its industrial district along Chestnut Creek in the core of the city. Due to disastrous flooding problems along Chestnut Creek (especially in 1940), the U.S. Army Corps of Engineers in 1950 channelized the creek through the downtown area and flood-proofed the industrial buildings located there.[123] Following the flood disaster from November 2003, Galax city officials said they had developed a P.E.R. to improve the drainage system to help alleviate flooding problems, but this was not in the city budget at this time.

The city's building codes are in line with the most recent statewide revisions known as the Uniform Statewide Building Code, which took effect October 1, 2003.[124] These modern codes help to offset the impacts of natural hazards such as winds for new construction.

For emergency response, the City of Galax participates in the Twin County E-911 system, which covers the entire city, along with the adjoining counties of Carroll and Grayson. Responders include volunteer fire departments and rescue squads, local police and sheriff's departments, and the state police.

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[122] However, properties located outside of the defined floodplain received disaster assistance from FEMA as a result of recent flooding in Galax, according to the state Department of Emergency Management.
[123] From "City of Galax Comprehensive Plan: 1996-2016," by City of Galax, page III-1. May 1996.
[124] The USBC is based on nationally recognized model building and fire codes produced by the International Code Council, Inc.

Recommended Mitigations: City of Galax

Table No. 44: City of Galax, Virginia Mitigations

Rank	Activity	Hazard Addressed
High	Educate residents on methods recommended by the American Red Cross to prepare for various types of natural disaster.	Floods Snowstorms/Ice High Winds
Medium	Support development of strategic wildfire risk reduction plans such as being promoted by the New River-Highlands RC&D Council.	Wildfire
Medium	Support educational programs to promote Firewise methods to affected residents of woodland communities. An estimated 67 homes in Galax are in wooded settings and at risk of wildfire.	Wildfire

Lessons Learned From Hazard Mitigation Study

The following brief narrative outlines some of the chief issues we have faced in the development of this first Pre-Disaster Hazard Mitigation Plan for the Mount Rogers Planning District region of southwest Virginia.

1) Hazard mitigation is familiar mainly to those who deal with emergency response, but the concept is not widely understood by the general public.

2) The recommended FEMA methods and how-to guides were helpful, but only to a limited extent. FEMA methods generally presumed access to data-intensive resources on the local level, including well-developed Geographic Information Systems, digitized FEMA flood maps, methods and databases for calculating the impacts of various storms, etc. For the most part these resources were lacking for localities in the Mount Rogers region.

3) The process of collecting and analyzing data proved to be very time-consuming. Some of the methods recommended by the FEMA how-to guides simply fell beyond the scope of our capabilities and time.

4) Localized data was lacking for several identified natural hazards. These include drought, karst/sinkholes, landslides, thunderstorms/lightning, and windstorms. For karst and landslides, some of the basic localized mapping simply had not been done. In other instances, impacts of major storm events found through the National Climatic Data Center were reported for wide regions; this limited the ability to perform analysis on a localized level.

5) Given the extremely limited financial resources of the rural areas, the ability to implement many of the recommended hazard mitigations will depend on access to outside grant funding, mainly on a competitive basis.

6) Flood hazard mitigation, which ranks as the top need for the region, is difficult to carry out under almost any circumstances due to lack of funding, community resistance to change, and agency requirements. This has been the case with past flood mitigation efforts undertaken by the Mount Rogers Planning District Commission, as well as other parts of the country. While the need is clearly there, the challenges remain daunting.

Plan Implementation and Maintenance

Section 5

Implementation of Mitigation Strategy

Some Observations

Successful implementation of the Pre-Disaster Hazard Mitigation Plan for the Mount Rogers Region in Virginia depends on part on efforts already underway and in part on new projects yet to come. The new projects, especially the costly ones, will come about only as a result of:

a) **Local community resolve;**
b) **United action;**
c) **Access to outside grant funding.**

The Mount Rogers Region is poor, sparsely populated, has limited local government staffing, and has highly limited financial resources to provide little other than the most basic government services.

Past experiences by the Mount Rogers Planning District Commission in the planning and the implementation of post-disaster flood mitigation projects (in the towns of Damascus and Chilhowie) have proven how difficult and complex these projects can be. Comprehensive flood mitigation recommendations have carried price tags far beyond the ability of the local region to pay for it through grants. The comprehensive projects of the 1970s and 1980s were pared down to try and achieve the best results possible within available funds.

Even then, proposed projects had to be re-thought and re-structured, faced numerous bureaucratic obstacles, faced problems caused by mis-communications and local rumors, and encountered problems caused by personality conflicts and those with personal agendas (one instance involved opposition against relocation of poor black families out of the floodplain into white neighborhoods). Major structural projects – such as removal of abandoned dams and other in-stream obstructions – proved to be out of the question, as did proposals to channelize waterways, rebuild roads, lengthen bridges, and install levee-and-pump-station facilities to protect some key local industries and government facilities. Further complications came from agency opposition – due to the presence of endangered and threatened aquatic species – and community resistance to change.

All the stakeholders must be on board and working together in order for any major project to succeed. Regardless of the type of natural hazard, those most affected are almost always those least able to help themselves. These factors make it doubly important to strive to achieve effective and affordable hazard mitigation working hand-in-hand with effective emergency response practices.

Implementation Plan

Table No. 45 shows mitigation goals, objectives, and proposed implementation schedule for each. These are recommendations to be followed when opportunities arise (especially for high-cost projects dependent on outside funding) or when localities, or other groups, wish to implement educational initiatives; examples include the Firewise program, which is being

implemented in some parts of the Mount Rogers district, and ongoing disaster education efforts by the American Red Cross and other similar groups.

These recommendations are intended as a guideline for the use of the localities and to help meet requirements for preparing this plan. This strategy is not intended to be treated as rigid or exclusive in nature. It is expected that over time hazard mitigation goals and objectives – as well as the proposals for implementation – will change as needs and/or opportunities change that affect the localities in the region.

Table No. 45: Hazard Mitigation Implementation Strategy
Mount Rogers Region, Virginia
2004-2009

Goal 1) Protect lives and property from damage and/or destruction due to natural hazards.		
	Who Implements	**When?**
a) Implement on-the-ground projects to reduce natural hazard risks.	MRPDC Individual localities	As opportunities arise.
b) Promote the need for pre-disaster hazard mitigation to help reduce future losses.	MRPDC, VDEM, FEMA American Red Cross	On-going. On MRPDC website, starting in 2005.
c) Promote useful programs, such as the National Flood Insurance Program.	MRPDC, VDEM, FEMA	2005-2009
Goal 2) Improve data resources to improve the quality of local hazard risk assessments.		
	Who Implements	**When?**
a) Update FEMA floodplain maps as applicable throughout the Mount Rogers region.	MRPDC and localities (through grant proposals)	As opportunities arise, as soon as 2005.
b) Develop new FEMA floodplain maps for flood-prone areas not previously mapped.	MRPDC and localities (through grant proposals)	As opportunities arise, as soon as 2005.
c) Support efforts to improve data resources for dam safety, drought, karst and sinkholes, landslides, thunderstorms and lightning, and windstorms.	State government Federal government Virginia Tech	As opportunities arise. Some efforts already underway.

Goal 3) Inform the Mount Rogers region community of the importance of natural hazard mitigation.		
a) Post the Pre-Disaster Hazard Mitigation Plan on the MRPDC website.	**Who Implements**	**When?**
	MRPDC	2005
b) Provide copies of the Plan to the 20 local jurisdictions in the region.	MRPDC	2005
c) Publicize successful efforts to reduce risk from natural hazards.	MRPDC, VDEM	2006 and later
Goal 4) Make efficient use of public funds for hazard mitigation.		
	Who Implements	**When?**
a) Support projects offering the best benefit/cost ratio.	MRPDC, localities, state and federal agencies, depending on proposal needs.	Ongoing.
b) Develop projects that can achieve multiple social, community, economic, and hazard mitigation goals.	MRPDC and localities	As opportunities arise.
Goal 5) Where possible, recommend sustainable, low-cost alternatives.		
	Who Implements	**When?**
a) Promote prevention methods homeowners can undertake, such as the Firewise program and methods to cope with drought.	MRPDC (website), agencies such as VDOF, New River-Highlands RC&D Council, others as appropriate.	Ongoing.
b) Support educational efforts of existing organizations such as the American Red Cross.	MRPDC (website), American Red Cross, other help agencies	Ongoing.

Goal 6) For flood mitigation the following guidelines should apply:		
	Who Implements	**When?**
a) A property is a candidate for relocation out of the floodplain if the first floor has been flooded twice (or more) within 50 years.	MRPDC, localities	As opportunities arise.
b) A property is a candidate for elevation or flood-proofing if the structure sustains flooding below the first floor twice (or more) within 50 years.	MRPDC, localities	As opportunities arise.
c) All relocation projects should meet the requirements of the Uniform Relocation Act.	MRPDC, localities	As opportunities arise.
d) Top priorities for federal relocation assistance should be based on need, frequency of flooding, and a favorable benefit/cost ratio.	Localities, with assistance from the MRPDC and state and federal agencies.	As opportunities arise.
e) Investigate and consider implementation of alternatives such as Low-Impact Development.	Localities, with assistance from MRPDC and other qualified advisors.	Uncertain.
Goal 7) Improve emergency response to all forms of natural disasters:		
	Who Implements	**When?**
a) Encourage localities to maintain and use effective, updated Emergency Operations Plans.	Localities.	Ongoing. No certain timeline.
b) Encourage volunteer responder groups (fire departments, rescue squads) to find ways to hire paid professional responders to improve quality of service, especially during daytime hours when volunteers are not always available.	Volunteer responder groups working in concert with the localities.	No certain timeline.

Funding Resources

This plan makes no attempt to create a comprehensive listing of all possible funding resources, since any given project or initiative has to be evaluated on an individual basis. It may be that in some cases, very little if any new funding would be needed for some kinds of projects, such as making use of existing programs and resources of others. In other cases, a major undertaking such as relocating families, businesses, and/or structures out of the floodplain may require significant funding from multiple sources.[125]

A detailed listing can be found in the Appendices attached to this Plan.

Plan Maintenance

Preparation of the Pre-Disaster Hazard Mitigation Plan for the Mount Rogers region of Virginia has been made possible with grant support made available through FEMA. Certain requirements apply for maintenance and future updates to the Plan, as detailed by the Disaster Mitigation Act of 2000 and through training workshops sponsored by the Virginia Department of Emergency Management.

The best maintenance approach is one that is fairly simple and straightforward, without imposing undue burdens on the Mount Rogers Planning District Commission or its 20 local jurisdictions (six counties, two cities, and 12 towns). The following steps provide an outline for Plan maintenance:

1) Move the Mount Rogers Hazard Mitigation Advisory Team from ad hoc to permanent status to serve as a vehicle for ongoing public review and input, working in cooperation with the Mount Rogers Planning District Commission.

2) Convene the Hazard Mitigation Advisory Team once a year to briefly review the Pre-Disaster Hazard Mitigation Plan, its goals and objectives, and to discuss hazard mitigation initiatives undertaken in the past year. This will be a shared effort with the Mount Rogers Planning District Commission and the localities.

3) Document any initiatives that either have been put into action or accomplished as described in the Plan. This can also include other efforts that may not have been directly mentioned in the contents of the Plan as prepared in 2004.

4) Add all local hazard mitigation updates to the Plan and also announce them on the MRPDC's Internet Web Site, as a vehicle for communicating with the localities.

[125] Information taken from The National Association of Resource Conservation & Development Councils Fact Sheet on Emergency Preparedness, as well as various FEMA guides.

5) Present the updated document to each of the 20 local jurisdictions for their input and formal approval by resolution every five years as the comprehensive plan is updated , to meet requirements by the Disaster Mitigation Act of 2000.

6) Make adjustments as needed to meet changing regulatory needs, incorporate improved hazard assessment data, and to meet changing needs of the 20 local jurisdictions. In the future, for example, disaster planning for human-caused hazards (including terrorism) may become required elements of the Pre-Disaster Hazard Mitigation plans. In that event, more funding resources will be required to carry out the necessary planning activities.

Record of Adoption by Jurisdictions

Section 6

Appendices

Contents:

Contributors to Plan Development

Table No. 1A: Participants in the Hazard Mitigation Advisory Team Mount Rogers Region, Virginia

Name	Capacity or Position	Community Represented
Berlen Hill	VA Dept. of Transportation	Mount Rogers region
Jack Rowell	VA Dept. of Emergency Management	VDEM Region 4
Edwin Ward	City Engineer	City of Galax
James Keen	VA Dept. of Transportation	Mount Rogers region
Rick Miller	American Electric Power	Southwest Virginia
Judy Osborne	VA Dept. of Environmental Quality	Southwest Virginia
Randy Bennett	Town Engineer	Town of Hillsville
Katie Gamble	E-911/Emergency Services Coordinator	Bland County
Todd Branscome	Emergency Services Coordinator	Wythe County
Ed Stoots	Region 6 Forester, VDOF	Southwest Virginia
Kenneth Vaught	Town Manager	Town of Independence
Bill Rush	Town Manager	Town of Chilhowie
Steve White	VA Dept. of Health	Regional EMS Council
Mike Roberts	Police Chief	Town of Marion
John Clark	Town Manager	Town of Marion
Mike Jones	Town Manager (also MRPDC staff)	Town of Saltville
Toby Boian	Town Manager (also MRPDC staff)	Town of Damascus
Thomas Taylor	MRPDC Executive Director	Mount Rogers region

Note: This is the group as assembled on May 21, 2004.

Table No. 1A-1: Participants in the Hazard Mitigation Advisory Team Mount Rogers Region, Virginia*

Name	Capacity or Position	Community Represented
Roy L. Gilliland	Emergency Services Coordinator	Carroll County
Jeffrey L. Smith	Town Manager	Town of Saltville
Kenneth Vaught	Town Manager	Town of Independence
Ed Stoots	Region 6 Forester, VDOF	SW Region of Virginia
Rick Miller	American Electric Power	Region
Randy Bennett	Town Engineer	Town of Hillsville
Jack Rowell	Virginia Dept. of Emergency Mgmt.	SW Region of Virginia
James Dillon	GIS Specialist	MRPDC
David Barrett	Town Manager (Glade Spring)	MRPDC
Thomas G. Taylor	Executive Director	MRPDC
Kim E. Hummel	Regional Planner – Land Use	MRPDC

* Note: This is the group as assembled on October 20,2004.

Table No. 2A: Government Participants

(Primarily from surveys conducted by MRPDC)

Name	Capacity or Position	Community Represented
Katie Gamble	Emergency Services Coordinator	Bland County
Mark Bolt	Building Enforcement	Carroll County
Don Young	County Administrator	Grayson County
Charles Harrington	Emergency Services Coordinator	Smyth County
Duncan McGregor	County Engineer	Smyth County
Mary Fraysier	Emergency Services Coordinator	Washington County
Heather Lawson	GIS Assistant	Washington County
Mark Reeter	County Administrator	Washington County
Cellell Dalton	County Administrator	Wythe County
Steven Bear	Asst. County Administrator	Wythe County
Ken Hurst	Building Enforcement	Wythe County
Todd Branscome	Emergency Services Coordinator	Wythe County
Bill Dennison	Asst. City Manager	City of Bristol
Edwin Ward	City Engineer	City of Galax
Albert Bradley	Planning Director	Town of Abingdon
C.M. Vernon, Jr.	Public Works Director	Town of Abingdon
Bill Rush	Town Manager	Town of Chilhowie
Toby Boian	Town Manager	Town of Damascus
Jack Gardin	Town Manager	Town of Fries
David Barrett	Town Manager	Town of Glade Spring
David Kidd	Town Engineer	Town of Hillsville
Hugh Cooper	Town Manager	Town of Independence
John E.B. Clark	Town Manager	Town of Marion
Cecil Hicks	Town Engineer	Town of Marion
Ray Matney	Town Manager	Town of Rural Retreat
Toby Boian	Town Manager	Town of Saltville
Scott Booth	Town Manager	Town of Troutdale

Wayne Sutherland	Town Manager	Town of Wytheville
Trevor Hackler	GIS Technician	Town of Wytheville
Steve Counts	Regional Resource Specialist	VA Dept. of Forestry
Ed Stoots	Regional Forester	VA Dept. of Forestry
Fred Rogers	District Conservationist	USDA-Carroll/Grayson counties
Ron Hale	FSA Executive Director	USDA-Carroll/Grayson counties
K.D. Cook	District Conservationist	USDA-Smyth County
Doug Eastep	FSA Executive Director	USDA-Smyth County
Fred Copenhaver	District Conservationist	USDA – Washington County
Wayne Turley	Conservation Specialist	Holston River SWCD
Gene Harris	District Conservationist	USDA – Wythe County
John Moody	FSA Executive Director	USDA–Wythe County
Claude Hutton	State Fire Marshall	VA Fire Marshall's Office
Deborah Mills	State Hazard Mitigation Planner	VA Dept. Emergency Mgmt
Michelle Pope	State Hazard Mitigation Planner	VA Dept. Emergency Mgmt.
Elaine Meil	Hazard Mitigation Planner	VA Dept. Emergency Mgmt.
Paige Bordwine	Grant Writer	Mount Rogers Health District
Staff	State Geologists	VA Dept. Mines, Minerals and Energy
Todd Boatman	Federal Engineer	U.S. Army Corps of Engineers
Craig Carrington	Federal Engineer	U.S. Army Corps of Engineers
Kyle Hayworth	Federal Engineer	U.S. Army Corps of Engineers
Wayne Easterling	Federal Engineer	U.S. Army Corps of Engineers
John Hunter	Federal Engineer	U.S. Army Corps of Engineers
Chip Hall	Federal Engineer	U.S. Army Corps of Engineers

Table No. 3A: Non-Profit Community/Other Participants

(Primarily from surveys conducted by MRPDC)

Name	Capacity or Position	Community Represented
John Arthur	Executive Director	American Red Cross – Smyth County Chapter
Patty Tauscher	Staff	American Red Cross – Bristol, VA
Susan Ferraro	Executive Director	Smyth County United Way
Linda Farmer	Staff	Twin County United Way
Gary Boring	Executive Director	New River-Highlands RC&D Council
Joe Bergandi	Strategic Planner	New River-Highlands RC&D Council
Katie Dalton	Executive Director	Carroll County Chamber of Commerce
Judy Brannock	Executive Director	Galax/Carroll/Grayson Chamber of Commerce
Tammy Sauls	Staff	Smyth County Chamber of Commerce
Brandy ??	Staff	Wythe/Bland Chamber of Commerce
Linda Bradshaw	Staff	Bland County Historical Society
Staff	Historical Archives	Smyth-Bland Regional Library (Marion)
Dr. Charles Bartlett	Geologist	Bartlett Geological Consultants
Dan Adams	Public Relations	American Electric Power
Rick Miller	Kingsport, TN office	American Electric Power
Lydeana Martin	Planner	New River Valley Planning Dist. Comm.
Dr. Shane Parson	Project Director for Geospatial Information	Virginia Tech University

Table No. 4A: High-Hazard and Significant-Hazard Dams
Mount Rogers Region, Virginia

Dam and Location	Nearest Downstream Community	Dam Height and Max. Capacity*	Drainage Area (Sq. Miles)	Year Done	Hazard Potential**	Emergency Action Plan in Place***	Owner Type	Main Use
Crab Orchard Creek Dam (Bland County)	Bland	51 ft high 550 acre-ft	4.98	1953	High (recent upgrade)	Yes	Private	Recreation
Byllesby Dam (New River, Carroll County)	Ivanhoe Austinville	63 ft. high 2034 acre-ft	1,310	1912	High	Federal Regs	Public Utility (AEP)	Hydroelectric
Buck Dam (New River, Carroll County)	Ivanhoe Austinville	45 ft. high 708 acre-ft	1,320	1912	High	Federal Regs	Public Utility (AEP)	Hydroelectric
Stewarts Ck-Lovills Ck Dam #9 (Carroll County)	Mt. Airy, NC	88 ft. high 7415 acre-ft	20.92	1990	High	Yes	Local Govmt (Carroll County)	Recreation
Hidden Valley Estates Dam (Grayson County)	Not given	29.4 ft. high 77 acre-ft	0.2	1989	Significant	Yes	Private	Recreation
Laurel Creek Dam (Laurel Creek, Grayson County)	Fox Creek	24 ft. high 60 acre-ft	0	1974	Significant	Not Yet (formerly size exempt)	Private	Recreation
Fields Dam (New River, Grayson County)	Fries	14 ft. high 2000 acre-ft	0	1930	Significant	Not Yet (formerly size exempt)	Private	Hydroelectric
Hale Lake Dam (Wolf Pen Branch, Grayson County)	Not given	30 ft. high 53 acre-ft	0	1965	Significant	Federal Regs	Federal (U.S. Forest Service)	Fish & wildlife
Hungry Mother Dam (Smyth County)	Marion	45 ft. high 2500 acre-ft	12.9	1934	High	Yes	State (DCR)	Recreation
Beaver Creek Dam (Washington County)	Bristol	85 ft. high 5020 acre-ft	13.7	1965	High	Federal Regs	Federal (TVA)	Flood control
Clear Creek Dam (Washington County)	Bristol	51 ft. high 2825 acre-ft	5.75	1965	High	Federal Regs	Federal (TVA)	Flood control
Edmondson Dam (Middle Fork Holston River, Washington County)	Mock Mill	47 ft. high 2620 acre-ft	0	1921	Significant	Federal Regs	AEPSCO	Hydroelectric
Hidden Valley Lake Dam (Brumley Creek, Washington County)	Duncanville	40 ft. high 1975 acre-ft	1.67	1964	Significant	Yes	State (VDGIF)	Recreation
Rural Retreat Dam (S. Fork Reed Creek, Wythe County)	State Rt. 749	41 ft. high 2266 acre-ft	3.34	1967	High	Yes	State (VDGIF)	Recreation

Sources: National Inventory of Dams maintained by the U.S. Army Corps of Engineers; consultations with local emergency services coordinators; consultations with Virginia state dam safety officials.

Earthquake Damage Estimates Using HAZUS 99-SR2

Table No. 5A: Earthquake Damage Estimates Using HAZUS Model
Building Damage by General Occupancy and by Locality
(based on Giles scenario at 6.3 magnitude)

Locality	Square Footage at Risk	Probability of Damage (%)				
		None	Slight	Moderate	Extensive	Complete
Bland Co. residential	4,097	59.50	22.00	13.5	3.50	0.50
Bristol City residential	11,616	95.00	3.25	1.00	0	0
Carroll Co. residential	17,172	67.57	12.00	5.29	0.86	0
Galax City residential	4,274	42.00	5.50	2.00	0.50	0
Grayson Co. residential	10,371	85.67	9.67	4.00	0.33	0
Smyth Co. residential	18,743	87.57	9.14	3.57	0	0
Washington Co. residential	27,339	83.55	5.36	1.64	0	0
Wythe Co. residential	14,832	72.75	17.00	8.25	1.50	0
MRPDC all categories	142,302	67.98	8.54	4.60	0.88	0.06

computer model is based on 1990 Census data.

The table shown at right contains an excerpt of data generated by HAZUS[126] regarding the damage potential from an earthquake with a 6.3 magnitude, which reflects the Giles earthquake of 1897. The selected data shows the probability of damage to residential buildings, since this category by far would sustain the most damage.

We chose the 6.3 magnitude based on the historical record and input from the MRPDC Executive Committee. Our best estimate is the Giles earthquake would have had a magnitude of 5.3-6.3 in the local region. We opted to use the higher magnitude to arrive at damage estimates in a worst case scenario.

Historically, the Giles earthquake of May 31, 1897 was the largest known earthquake originating in Virginia.

The probability of damages estimated by HAZUS understates the case since the

[126] We used the earthquake modeling program from HAZUS 99-SR2.

Table No. 6A: Earthquake History - Mount Rogers Region, Virginia

(Source: National Geophysical Data Center, division of the National Oceanic and Atmospheric Administration)

Date	U/G Conv	Earthquake Lat -Long	Mag	Depth (km)	Epicenter Distance	Locality Lat -Long	MMI	Locality	Data Source
March 10, 1828	U						5	Virginia (sw)	H
Apr. 29, 1852						36.95 -81.09	6	Wytheville	H
Sept. 1, 1886		32.90 -80.00			462	36.79 -81.78	5	Glade Spring	B
Sept. 1, 1886		32.90 -80.00			434	36.76 -80.73	2	Hillsville	B
Sept. 1, 1886		32.90 -80.00			458	36.83 -81.52	4	Marion	B
Sept. 1, 1886		32.90 -80.00			461	36.95 -81.09	5	Wytheville	B
May 31, 1897	U	37.30 -80.70			52	36.95 -81.09	6	Wytheville	H
Feb. 5, 1898						36.95 -81.09	3	Wytheville	H
Feb. 13, 1899		37.00 -81.00			9	36.95 -81.09	5	Wytheville	H
Feb. 21, 1916		35.50 -82.50			204	36.95 -81.09	3	Wytheville	W
July 15, 1921		36.60 -82.30			0	36.60 -82.30	6	Mendota (Near)	H
Nov. 3, 1928	U	36.00 -82.60			96	36.71 -81.98	5	Abingdon	U
Nov. 3, 1928	U	36.00 -82.60			76	36.60 -82.18	4	Bristol	U
Nov. 3, 1928	U	36.00 -82.60			147	36.62 -81.15		Independence	U
Nov. 3, 1928	U	36.00 -82.60			171	36.95 -81.09	4	Wytheville	U
Nov. 1, 1935		46.70 -79.06			1160	36.60 -82.18		Bristol	U
Sept. 28, 1955		36.60 -81.30			24	36.61 -81.02	3	Baywood	U
Sept. 28, 1955		36.60 -81.30			20	36.78 -81.29	3	Camp	U
Sept. 28, 1955		36.60 -81.30			33	36.89 -81.19	3	Crockett	U
Sept. 28, 1955		36.60 -81.30			11	36.70 -81.34	3	Flatridge	U
Sept. 28, 1955		36.60 -81.30			33	36.66 -80.93	3	Galax	U
Sept. 28, 1955		36.60 -81.30			35	36.76 -80.95	5	Grayson County	U
Sept. 28, 1955		36.60 -81.30			13	36.62 -81.15	4	Independence	U
Sept. 28, 1955		36.60 -81.30			3	36.59 -81.34	4	Mouth of Wilson	U
Sept. 28, 1955		36.60 -81.30			39	36.94 -81.44	3	Nebo	U
Sept. 28, 1955		36.60 -81.30			13	36.61 -81.45	4	Rugby	U
Sept. 28, 1955		36.60 -81.30			26	36.81 -81.17	3	Speedwell	U
Sept. 28, 1955		36.60 -81.30			16	36.70 -81.44	3	Troutdale	U
Sept. 28, 1955		36.60 -81.30			7	36.63 -81.38	4	Volney	U
Sept. 28, 1955		36.60 -81.30			43	36.95 -81.09	3	Wytheville	U
Jan. 17, 1963						36.60 -82.18	3	Bristol	U
Oct. 28, 1963	G	36.70 -81.00			31	36.59 -80.67	3	Cana	U
Oct. 28, 1963		36.70 -81.00			16	36.72 -81.18	4	Elk Creek	U

Oct. 28, 1963		36.70 -81.00			27	36.67 -80.69	4	Fancy Gap	U
Oct. 28, 1963		36.70 -81.00			2	36.72 -80.98	5	Fries	U
Oct. 28, 1963		36.70 -81.00			7	36.66 -80.93	5	Galax	U
Oct. 28, 1963	G	36.70-81.00			24	36.76 -80.73	3	Hillsville	U
Oct. 28, 1963		36.70 -81.00			16	36.62 -81.15	4	Independence	U
Oct. 28, 1963		36.70 -81.00			5	36.66 -80.96	5	Oldtown	U
Oct. 28, 1963		36.70 -81.00			407	38.71 -77.13	4	Woodlawn	U
Oct. 29, 1963						36.84 -80.97	4	Ivanhoe	U
March 8, 1968	G	37.00 -80.50	3.9		56	37.10 -81.12	3	Bland	U
March 8, 1968	G	37.00 -80.50	3.9		33	36.76 -80.73	3	Hillsville	U
March 8, 1968	G	37.00 -80.50	3.9		52	36.95 -81.09	3	Wytheville	U
July 13, 1969	G	36.10 -83.70	3.5		168	36.71 -81.98	3	Abingdon	U
Nov. 20, 1969		37.40 -81.00	4.3		115	36.71 -81.98	5	Abingdon	U
Nov. 20, 1969		37.40 -81.00	4.3		34	37.10 -81.12	4	Bland	U
Nov. 20, 1969		37.40 -81.00	4.3		75	36.76 -80.73	4	Hillsville	U
Nov. 20, 1969		37.40 -81.00	4.3		87	36.62 -81.15	4	Independence	U
Nov. 20, 1969		37.40 -81.00	4.3		78	36.83 -81.52	4	Marion	U
Nov. 20, 1969		37.40 -81.00	4.3		61	36.89 -81.28	5	Rural Retreat	U
Nov. 20, 1969		37.40 -81.00	4.3		50	36.95 -81.09	5	Wytheville	U
Sept. 10, 1970		36.10 -81.40		33	61	36.62 -81.15	4	Independence	U
Nov. 30, 1973	-	35.80 -83.96	4.7	3	204	36.71 -81.98	4	Abingdon	U
Nov. 30, 1973	-	35.80 –83.96	4.7	3	240	36.93 –81.67	4	Broadford	U
Nov. 30, 1973	-	35.80 –83.96	4.7	3	280	36.82 –81.10	4	Cripple Creek	U
Nov. 30, 1973	G	35.80 –83.96	4.7	3	215	36.64 –81.79	3	Damascus	U
Nov. 30, 1973	-	35.80 –83.96	4.7	3	269	36.72 –81.18	4	Elk Creek	U
Nov. 30, 1973	-	35.80 –83.96	4.7	3	246	36.83 –81.52	5	Marion	U
Nov. 30, 1973	G	35.80 –83.96	4.7	3	268	36.89 –81.28	-	Rural Retreat	Q
Nov. 30, 1973	-	35.80 –83.96	4.7	3	685	38.71 –77.13	4	Woodlawn	U
Nov. 30, 1973	G	35.80 –83.96	4.7	3	286	36.95 –81.09	-	Wytheville	Q
May 30, 1974	G	37.38 -80.42	3.6	8	142	36.77 -81.83	3	Emory	U
May 30, 1974		37.38 -80.42		8		37.30 -80.42	5	Virginia (Sw)	H
Sept. 13, 1976		36.60 -80.81	3.3	5	29	36.08 -80.92	4	Austinville	U
Sept. 13, 1976		36.60 -80.81	3.3	5	12	36.59 -80.67	5	Cana	U
Sept. 13, 1976		36.60 -80.81	3.3	5	35	36.82 -81.10	4	Cripple Creek	U
Sept. 13, 1976		36.60 -80.81	3.3	5	13	36.67 -80.69	5	Fancy Gap	U
Sept. 13, 1976		36.60 -80.81	3.3	5	13	36.67 -80.69	3	Fancy Gap	U
Sept. 13, 1976		36.60 -80.81	3.3	5	20	36.72 -80.98	5	Fries	U
Sept. 13, 1976		36.60 -80.81	3.3	5	12	36.66 -80.93	5	Galax	U

Sept. 13, 1976		36.60 -80.81	3.3	5	19	36.76 -80.73	4	Hillsville	U
Sept. 13, 1976		36.60 -80.81	3.3	5	30	36.62 -81.15	4	Independence	U
Sept. 13, 1976		36.60 -80.81	3.3	5	29	36.72 -80.52	2	Laurel Fork	U
Sept. 13, 1976		36.60 -80.81	3.3	5	68	36.83 -81.52	2	Marion	U
Sept. 13, 1976		36.60 -80.81	3.3	5	47	36.59 -81.34	4	Mouth of Wilson	U
Sept. 13, 1976		36.60 -80.81	3.3	5	57	36.70 -81.44	3	Troutdale	U
Sept. 13, 1976		36.60 -80.81	3.3	5	399	38.71 -77.13	4	Woodlawn	U
March 17, 1978		36.75 -80.74	2.8	7	19	36.85 -80.92	2	Austinville	U
March 17, 1978		36.75 -80.74	2.8	7	13	36.82 -80.61	3	Dugspur	U
March 17, 1978		36.75 -80.74	2.8	7	19	36.66 -80.93	4	Galax	U
March 17, 1978		36.75 -80.74	2.8	7		36.76 -80.73	4	Hillsville	U
March 17, 1978		36.75 -80.74	2.8	7	39	36.62 -81.15	2	Independence	U
March 17, 1978		36.75 -80.74	2.8	7	19	36.72 -80.52	4	Laurel Fork	U
March 17, 1978		36.75 -80.74	2.8	7	385	38.71 -77.13	4	Woodlawn	U
July 27, 1980		38.17 -83.91	5.1	8	235	36.71 -81.98	3	Abingdon	U
July 27, 1980		38.17 -83.91	5.1	8	232	36.60 -82.18	3	Bristol	U
July 27, 1980		38.17 -83.91	5.1	8	232	36.60 -82.18	2	Bristol	U
July 27, 1980		38.17 -83.91	5.1	8	258	36.83 -81.52	2	Marion	U
July 27, 1980		38.17 -83.91	5.1	8	283	36.95 -81.09	4	Wytheville	U

PLEASE NOTE:
U/G: Unpublished or grouped intensity
U = Intensity (MM) assigned that was not listed in the source document.
G = Intensity grouped I-III in the source document was reassigned intensity III.

Epi Dis: Epicentral Distance in km that the reporting city (or locality) is located from the epicenter of the earthquake.

MMI: Modified Mercalli Scale Intensity is given in Roman Numerals. Values range from I to XII (converted to numbers in the database).

Data Source: This is a code referring to the source of one or more of the reported parameters (e.g., epicenter, city and intensity). References are listed below.
B = Report by Bollinger and Stover, 1976.
C = Quarterly Seismological Reports, 1925-27.
H = Earthquake History of the United States.
K = Report by Carnegie Institution, 1908, 1910.
N = Report by Nuttli, 1973.
Q = Abstracts of Earthquake Reports for the United States, 1933-70.
S = Unpublished report by Nina Scott, 1965.
W = Monthly Weather Service Seismological Reports, 1914-24.
Blank = United States Earthquakes, 1928-85.

Table No. 7A: Estimated Property Values in Flood-Prone Areas
Mount Rogers Region, Virginia

Locality	Class of Property	1 Number in Class	2 Avg. Value Land & Improvmts	3 Total Value (Cols. 1x3)
Bland County	-	-	-	-
Bastian Community	Resid.	6 homes	$48,804	$292,824
-	-	13 mobile homes	NA	NA
-	-	-	-	-
Bland Community	Resid.	15 homes	$48,804	$732,060
-	-	-	-	-
Rocky Gap Community	Resid.	33 homes	$48,804	$1,610,532
-	-	12 mobile homes	NA	NA
-	-	-	-	-
Wolf Creek Community	Resid.	9 homes	$48,804	$439,236
Carroll County	Resid.	20 homes	$48,804	$976,080
Town of Hillsville	-	no structures in floodplain	NA	NA
-	-	-	-	-
Grayson County	Resid.	10 homes	$48,804	$488,040
Town of Fries	-	little in identified floodplain	-	-
Town of Independence	-	no identified floodplain	-	-
Town of Troutdale	-	no identified floodplain	-	-
Smyth County	-	-	-	-
Town of Chilhowie	Resid.	57 homes	$84,444	$4,813,308
-	Comm.	18 businesses	$715,739	$12,883,302
-	Industry	1 (Deer Valley Ind. Park)	$4,002,400	$4,002,400
-	Govmnt	6 structures	$1,735,267	$10,411,602
-	Non-Profit	5 structures	$160,080	$800,400
-	-	-	-	-
Town of Marion	Resid.	156 homes	$34,878	$5,440,968
-	Comm.	39 businesses	$144,879	$5,650,281
-	Industry	2 industries (4 sites)	$1,510,475	$6,041,900
-	Govmnt	4 structures	$396,900	$1,587,600
-	Non-Profit	11 structures	$120,809	$1,328,899
-	-	-	-	-
Town of Saltville	Resid.	100 homes	$34,205	$376,255
(including Allison's Gap area)	Comm.	8 structures	$364,300	$2,914,400
-	Industry	Metso Minerals	$669,300	$669,300
-	Govmnt	3 structures	$2,737,033	$8,211,099
-	Non-Profit	1 church, 2 civic groups	$119,800	$359,400
	-	-		
Atkins Community	Resid.	22 homes	$48,804	$1,073,688
		46 mobile homes	NA	NA
	Industry	5 structures		
Broadford Community (east of Saltville)	Resid.	70 homes	$48,804	$3,416,280
Sugar Grove Community	Resid.	79 homes	$45,608	$3,603,032
-	Comm.	1 business	$45,000	$45,000
-	Non-Profit	4 structures	$89,315	$357,260

Notes:
Value of land and improvements generally based on tax-appraised values.
Residential property values in Bland, Carroll, Grayson and Wythe counties based on average of values for Chilhowie, Marion, Saltville, Damascus, Glade Spring, and Sugar Grove.

(continued next page)

Table No. 7A (continued): Estimated Property Values in Flood-Prone Areas
Mount Rogers Region, Virginia

Locality	Class of Property	1 Number in Class	2 Avg. Value Land & Improvmts	3 Total Value (Cols. 1x3)
Washington County	-	-	-	-
Town of Abingdon	Resid.	100 homes or townhouses	$100,424	$10,042,400
-	Comm.	18 businesses	$356,867	$6,423,606
-	Industry	1 structure	$98,100	$98,100
-	Govmnt	5 structures	$396,160	$1,980,800
-	Non-Profit	4 structures	$518,975	$2,075,900
-	Other	1 structure	$367,200	$367,200
-	-	-	-	-
Town of Damascus	Resid.	86 homes	$51,998	$4,471,828
-	Comm.	6 businesses	$155,033	$930,198
-	Industry	-	-	-
-	Govmnt	4 structures	$94,700	$378,800
-	Non-Profit	2 structures	$451,750	$903,500
-	-	-	-	-
Town of Glade Spring	Resid.	8 homes	$41,688	$333,504
-	Comm.	8 businesses	$35,513	$284,104
-	Industry	-	-	-
-	Govmnt	2 structures	$67,350	$134,700
-	Non-Profit	2 structures	$100,950	$201,900
-	-	-	-	-
Wythe County	-	-	-	-
Town of Rural Retreat	-	8 homes	-	$470,000
-	-	-	-	-
Town of Wytheville	Resid.	53 homes	$48,804	$2,586,612
-	Comm.	31 businesses	$295,389	$9,157,059
-	Industry	-	-	-
-	Govmnt	9 structures	$904,568	$8,141,112
-	Non-Profit	2 structures	$223,097	$446,194
-	-	-	-	-
Max Meadows community	Resid.	20 SF homes	$48,804	$976,080
-	-	-	-	-
City of Bristol				
City of Galax	-	-	-	-
(near Chestnut Creek)	Resid.	25 homes	$48,804	$1,220,100
(Mill Creek – no identified floodplain)	Resid.	30 homes (Mill Creek)	$48,804	$1,464,120
(Mill Creek – no identified floodplain)	Resid.	151 mobile homes (Mill Creek)	NA	NA
(in floodplain)	Industry	15 structures (floodproofed)	NA	NA

Notes:
Value of land and improvements generally based on tax-appraised values.
Residential property values in Wythe County, Wytheville, Max Meadows, and City of Galax based on average of values for Chilhowie, Marion, Saltville, Damascus, Glade Spring, and Sugar Grove.
Commercial and government property values in Wytheville based on average of values for Chilhowie, Marion, Saltville, Abingdon, Damascus, Glade Spring. Non-profit property values in Wytheville based on average of values for Chilhowie, Marion, Saltville, Abingdon, Damascus, Glade Spring and Sugar Grove.

Water Issues in the Mount Rogers Region

(Data taken from a series of 604(b) water and sewer studies from the mid- to late-1990s)

Table No. 8A: Bland County - Existing and Future Water Needs

Summary: In 1998 approximately 23% of the county's population of 7,053 was served by community water systems. The main systems include those provided by the Bland County Service Authority in Bland and Rocky Gap/Bastian, Bland Correctional Center, Deer Run Water Company (for a subdivision), Kegley Manor Nursing Home and Waddle's Trailer Park.

Community or Facility	Issue	Recommendation
Laurel Creek (west of I-77 along Rte. 613)	Poor well water quality, with high levels of iron. No fire protection.	Extension of Rocky Gap/Bastian system from Rte. 21/52 west.
West of Bastian, along Routes 646 and 615	Poor well water quality.	Extension of Rocky Gap/Bastian system.
Bastian/Bland Connection	High cost of labor and upkeep for Bland water plant.	Eventual abandonment of Bland plant and connection to Rocky Gap/Bastian system over Brushy Mountain.
Deer Run water system (serving residential subdivision)	Lacks proper maintenance. Limited source capacity and storage. No fire protection.	Extension of Rocky Gap system east along Wolf Creek.
Hollybrook/Mechanicsburg	Poor well water quality. High levels of iron/sulphur/bacteria.	Possible future public water supply from an existing artesian well.
Bland water system (serving area west of I-77)	Undersized 2-inch water main. Much leakage due to inferior piping in distribution system first built in 1960s.	Upgrade water main to 6 inches and extend west along Route 21/52. Replace entire distribution system. Extend system east along Rte. 42 to serve new growth area.

Future growth seen **along I-77 corridor** and around the exits near Rocky Gap, South Gap, Bastian and Bland. Ample water quantity available from main trunk line running from Bluefield, W. Va. (Bluefield Valley Waterworks Company) to Bastian.

The area east of I-77 is rural. Future development of a public water supply using a large artesian well could serve the Hollybrook area. Should this ever happen, moderate growth may occur in this area. Further residential and industrial development **west of Bland** along Route 21/52 and **east of Bland** along Route 42 should occur with extension of public water service to those areas.

Table No. 9A: Carroll County - Existing and Future Water Needs

Summary: In 1998 only about 8% of the population of 29,245 was served by community water systems. Others obtain water from private wells and/or springs. The major community systems are those owned or operated by the Carroll County Public Service Authority in Cana, Carroll County Industrial Park, Gladeville/Cranberry area, Hill Crest Estates, Pine Brook and Woodlawn. Hillsville supplies water to 580 connections. Several smaller systems serve trailer parks, private developments, individual schools and small subdivisions.

Community or Facility	Issue	Recommendation
Laurel Community (along Routes 743 and 740)	High levels iron/manganese in the groundwater.	
Sylvatus Community (northern Carroll County)	High iron levels in the groundwater.	Potential future extension of public water service along Rte. 100.
Poplar Camp	Reliant on well water.	Potential future service from proposed regional water plant in Austinville area of Wythe County.
Sheeptown Community (near Wythe County line)	High iron levels in well water/ private springs. Isolated.	Potential extension of public water from Poplar Camp.
Cana	Has brand new public water system with 420 connections. New well development difficult.	
Surry County, N.C. connector	Future development of Cana system unlikely with wells, which tend to produce low yields.	Connection with the Mount Airy system in Surry County, N.C. as backup supply.
Sandy Ridge Community (west of Rte. 52)	Groundwater is extremely difficult to predict. Many drillings for wells turn up dry.	Future expansion of Cana water system.
Lambsburg Community (2 miles west of Exit 1 of I-77)	Reliance on private wells.	Future expansion of Cana water system, via Sandy Ridge.
Mt. Bethel (east of Rte. 52 along Rte. 686)	Reliance on private wells.	Future expansion of Cana water system.
Fancy Gap	Private wells often inadequate in capacity and/or distribution.	Development of public system through Carroll County PSA.
Route 100 extension	Industrial/residential growth was pushing existing system to its limit.	More well development by Carroll County PSA.
Liberty Hill (east of Rte. 100 on Routes 753 and 767)	Poor quality and low quantity.	Extension of Rte 100 system by Carroll County PSA.
Laurel Fork (12 miles east of Hillsville along Rte. 58)	Reliance on private wells and/or springs. Private recreational development at nearby golf course.	Expansion of existing system serving Olde Mill Golf Course may be advisable in future.
Hillsville Annexation	Water treatment plant nearing 80% capacity.	Expansion of town system east along Rte. 58 to town limits and proposed subdivision.
Dugspur (7 miles northeast of Hillsville on U.S. Rte. 221)	Reliance on private wells/springs. Potential growth area.	

Vaughan (2 miles north of Fries)	People along Rte. 758 and the Hilltown Community would like public water.	Extension of water from Town of Fries.
Hickory Flat (2 miles north of City of Galax)	Some private wells too high in iron. Growth area.	Extension of water from City of Galax.
Iron Ridge (along Rte. 607 between Hickory Flat and Hebron)	Reliance on private wells. Water with high iron content.	Development of water systems for Hickory Flat, Hebron and Iron Ridge.
Hebron (4 miles north of Wolf Glade on Rte. 635)	Some wells produce very little water. Growth area.	Expansion of Gladeville/Cranberry water system.
Oakland (5 miles east of Galax on Rte. 97)	Reliance on private water sources. Water with high levels of lead and copper.	
Poplar Knob (2 miles east of Galax)	Reliance on private wells/springs. Sunrise Trailer Park system limited to 15 connections. Growth area.	
Crooked Creek (south of U.S. 58 between Hillsville and Galax)	Potential site of new 1 MGD surface water treatment plant.	May not be needed if new regional water plant on New River is developed.
I-77/Rte. 620 area (Laurel Community, Twin County Airport, Five Forks Community)	Lack of water has inhibited commercial and industrial growth.	Connect to the existing Woodlawn system. Install water mains along Routes 743 and 620.
Eona (along Routes 706 and 701, 2 miles SW of U.S. 58 and I-77)	Much population growth.	Extension of Woodlawn system.

The north planning area includes localities along the I-77, U.S. 52 and Rte. 100 corridors. There is no public water here. **Poplar Camp/743 Connector** would join with Wythe County systems in the event of a regional water plant on the New River. This could be major new water source for Carroll County. Same purpose would be served by public water development for **Poplar Camp/52 Corridor**. **Dalton Hill** shows potential for considerable residential growth due to proximity to I-77 and U.S. 52.

The south planning area, which includes **Cana**, shows good potential for growth. Connecting to **Mt. Airy, N.C.** water system would provide a reliable water supply in the long term, since well development near Cana is difficult. Future needs also are likely to come from nearby **Sandy Ridge** and **Lambsburg**.

The 1-77/Lambsburg area shows great potential for commercial and residential growth, but this has been inhibited by lack of public facilities. A connection to the Cana system via Sandy Ridge would stimulate growth. **Fancy Gap** needs public water due to proximity of U.S. 52, I-77 and the Blue Ridge Parkway. Several private water systems exist, but a public system will become necessary to support future growth.

The east planning area includes the **Town of Hillsville** and water systems owned by the Carroll County PSA. More residential growth may occur on **U.S. 58 east** of Hillsville and between Routes 58 and 221. Significant industrial and moderate residential growth will require more development of the **Rte. 100** system.

The west planning area, including **City of Galax** and **U.S. Route 58 corridor** between Hillsville and Galax, is expected to see much growth over 20 years. **Hebron**, **Poplar Knob** and **Eona** are all growing and in need of public water. High growth potential seen for **I-77/Route 620** area if public water is developed.

Table No. 10A: Grayson County - Existing and Future Water Needs

Summary: In 1998, approximately 10% of Grayson County's 16,881 residents were served by community water systems. The major systems are those provided by Troutdale, Fries and Independence, and the Board of Supervisors. Individual systems serve schools in Mt. Rogers, Providence, Flatridge, Elk Creek, Bridle Creek and Baywood. Water systems also are present in the Lawn Acres Trailer Park, Sun Valley Trailer Park, Oak Hill Academy and the Grayson Supply Company.

Community or Facility	Issue	Recommendation
Providence (2 mile north of U.S. 58 and 3 miles east of Fries)	Reliance on private wells/springs. High lead/copper content at local school. No fire protection.	Develop public water when there's enough population, public support and financing.
Elk Creek (8 miles north of Independence on US 21)	Reliance on private wells/springs. Groundwater corrosive.	Develop public water when there's enough population, public support and financing.
Town of Independence (juncture of Routes 58 and 21)	Existing system suffering from well contamination, well capacity reduction, corrosive well water, and fire flow restrictions.	Repair and upgrade as needed. Active participation in the New River Water Plant Study.
Independence-South (along Routes 21, 702 and 703)	Reliance on private wells/springs. No fire protection.	Expansion of Town of Independence system.
Independence-East (along 2.4 miles of U.S. 58)	Reliance on private wells/springs. No fire protection.	Expansion of Town of Independence system.
Independence-North (5.5 miles north of town along U.S. 21)	Reliance on private wells/springs. No fire protection. Recent residential growth.	Could become part of a connector between Independence and Elk Creek.
Baywood (east of Galax along Routes 626 and 636)	Growth area lacking public water. Has much potentially developable land. No fire protection.	Work with City of Galax to develop public water service.
Town of Fries (4 miles north of Galax at Carroll county line)	Water plant and distribution system aging and leaking.	Active participation in the New River Water Plant Study.
Stevens Creek (north of Fries and includes Hilltown)	Reliance on private wells/springs. Recent reports of dry wells, high iron levels, contamination.	Work with Town of Fries to supply public water.
Oglesby Branch (just north of Galax)	Some wells have high iron levels. No public water here.	Extension of proposed Oldtown system with connection to City of Galax water plant.
Meadow Creek (south of Galax on Routes 607 and 785, west of Rte. 89)	Reliance on private wells/springs. No fire protection.	Extension of Fairview system.
Snow Hill (along Routes 720 and 613, south of Galax and east of Rte. 89)	Reliance on private wells/springs.	Extension of Fairview system.
Mouth of Wilson (junction of U.S. 58 and Rte. 16)	Reliance on private wells/springs, except for community water system serving Oak Hill Academy.	Eventual public water.
Volney (Rte. 16/US 58 between Mouth of	Reliance on private wells/springs. No fire protection.	Eventual public water.

Wilson and Grant)		
Grant (on Rte. 16 between Volney and Troutdale)	Reliance on private wells/springs. No fire protection.	Eventual public water.
Whitetop (southwest corner of Grayson County near North Carolina state line)	Reliance on private wells/springs. System at Mt. Rogers school limited. No fire protection.	Eventual public water.

The north planning area includes Providence and Elk Creek, which have no public water. Public water would support continued moderate growth in **Providence**. The same is true for **Elk Creek**, which has some light industry, commercial businesses, homes, and an elementary school.

The south planning area includes the Town of Independence and surrounding communities. Improvements to U.S. 58, along with public water development, would stimulate commercial/industrial growth in the **Independence-South** area. The U.S. 58 bypass would also have great impact for **Independence-East**, offering opportunities for future commercial and industrial development.

Moderate growth seen for **Independence-North** area. Public water would support future development. **Baywood**, located one mile west of Galax, is a substantial community that needs public water to support future growth.

The east planning area includes the Town of Fries and communities surrounding City of Galax. Public water would support residential growth in **Stevens Creek**, **Oglesby Branch**, **Meadow Creek** and **Snow Hill**.

The west planning area includes the Town of Troutdale and the U.S. 58 corridor between Mouth of Wilson and Whitetop. This is not seen as a major growth area in the next 20 years. The **Mouth of Wilson** has experienced moderate residential growth. **Volney** may in the future need public water to support moderate growth and promote development. Like Volney, **Grant** is small but will need public water in the future.

The **Whitetop** community may experience some growth, but only with development of public water. The existing system serving the Mount Rogers school has a limited source capacity.

Table No. 11A: Smyth County - Existing and Future Water Needs

Summary: In 1997 public water service was provided to 76% of Smyth County's 33,100 residents. The major community water systems were operated by the three local towns, Thomas Bridge Water Corporation, Rye Valley Water Authority and Smyth County. Smaller systems served some of the local trailer parks.

Community or Facility	Issue	Recommendation
Town of Marion	Added water storage needed, along with emergency tie-ins to a backup supply. Much leakage.	Make repairs/upgrades as needed. Work on emergency water connection.
Town of Chilhowie	No emergency tie-in with backup supply. Water lines undersized and old. Much leakage. Springs surface water influenced.	Develop new water treatment plant with Washington County (has been done). Make repairs/upgrades as needed.
Town of Saltville	No emergency tie-in with backup supply. Distribution system is old and needs replacement. Much leakage.	Make repairs/upgrades as needed. Work on emergency water connection.
Thomas Bridge Water Corporation (serving Thomas Bridge, Adwolfe and Stony Battery)	Needs more storage capacity for fire protection and reliable service. Much leakage.	Make repairs/upgrades as needed. Work on emergency water connection.
Rye Valley Water Authority (serving Sugar Grove community)	No emergency tie-in with backup supply. Much leakage.	Make repairs/upgrades as needed. Work on emergency water connection.
Smyth County system	More water sources needed to expand system.	
Hutton Branch (along Routes 688, 689, and 690)	Extension of public water recently completed.	
Walker Creek/Ebenezer projects (serving western and northwestern Smyth County)	Public water critically needed in Greenwood, Long Hollow, Porter Valley, Mitchell Valley, Rte. 609/774 and Harris Lane.	Service to be supplied by Smyth County.
Horsehoe Bend and Chestnut Ridge projects	Public water critically needed in Horsehoe Bend, Chestnut Ridge, Vance Drive and Rte. 643).	Service to be supplied by Smyth County through purchase from Town of Chilhowie.
Watson Gap (east of Saltville)	Stand-alone system. No emergency alternate.	
Allison Gap (Poore Valley west of Saltville)	Connected to Saltville system. No emergency alternate.	
Atkins Extension, Nicks Creek, Currin Valley	Connected to Marion system. No emergency alternate.	
North Holston and Pleasant Heights communities	Need public water.	
Eastern Smyth County (east of Atkins)	Largest area of unmet need.	Extension of Atkins system east to Wythe County line.

The Chilhowie planning area is located along I-81 and U.S. 11 in central Smyth County. This includes Chilhowie, the US 11 corridor to Seven Mile Ford, and southwest Smyth County. Future water service was identified for Horseshoe Bend, Chestnut Ridge, Vance Drive, and Rte. 657 (Grubmore Road).

The west central planning area includes Walker Creek, Cleghorn Valley, Pleasant Heights, Midway and Beaver Creek. Future water service was identified for Rte. 643, Greenwood, Porter Valley, Rte. 609/774, Harris Lane, and Bear Creek.

The east central planning area is located along I-81 and U.S. 11 to the Wythe County line. It includes Atkins, Hutton Branch, Mitchell Valley, Nicks Creek, and Groseclose. Future water service was identified for Mitchell Valley, Nicks Creek, Rte. 690, Rte. 16 south, Rte. 686 south, Rte. 615/708, eastern Smyth County, Groseclose, Rte. 615 and Rte. 617 east.

The northern planning area goes from Saltville to the Bland County line. It includes Watson Gap, McCready, Broadford, Rich Valley and northern Smyth County. Future water service was identified for Long Hollow.

The Rye Valley planning area is located in southern Smyth County and includes Sugar Grove, Teas and southeastern Smyth County. Future water service was identified for Rte. 670 in the Teas area.

Table No. 12A: Washington County - Existing and Future Water Needs

Summary: In 1998 most residents were served by a community water system in this growing county of 51,000. The 604(b) water and sewer study from 1998 focused on public sewer needs and not public water, since this has been largely addressed in Washington County.

Community or Facility	Issue	Recommendation
Washington County Service Authority treatment plant	Built in 1974 and expanded in 1993-1994. New source capacity needed for future growth.	
Mill Creek Spring (off Rte. 604)	Spring surface-water influenced.	New membrane filtration plant in development between Washington County and Town of Chilhowie in Smyth County.
Swift Spring (part of Taylors Valley springs)	Was taken out of service due to surface water influence. Could be revitalized by addition of membrane filtration plant.	
Water storage facilities	More storage needed to facilitate water plant operations. Rehab needed for tanks at Route 58 and Abingdon. Tank replacement needed for Bristol Industrial Park and Hapco.	
Pump stations	Five of the 10 pump stations need rehab.	
Distribution system	Future need for major new lines and upgrades. Also need customer meter replacement program.	Line upgrades needed in Abingdon and Damascus systems, along with miscellaneous locations.

Table No. 13A: Wythe County - Existing and Future Water Needs

Summary: In 1995, 19% of the county's 27,600 population was served by community water systems. The main systems include those run by the towns of Wytheville and Rural Retreat and the Board of Supervisors (with systems in Ivanhoe/Max Meadows, Grahams Forge, Speedwell and Austinville). Other water suppliers included the New River Water Company (for a subdivision), Barren Springs Waterworks Inc. and Ridgedale Mobile Home Park.

Community or Facility	Issue	Recommendation
Big Survey Community (Rte. 643)	Local spring unsafe.	Connect to Ivanhoe/Max Meadows system.
Grahams Forge	System limited to 39 connections. Adequate fire protection.	Connect to Ivanhoe/Max Meadows for backup.
Austinville	System built in 1947. Plant needs much repair.	
Piney/Ivanhoe (Rte. 94)	Needs more storage to provide fire protection. Ivanhoe plant 25 years old.	New well in development in Fort Chiswell.
Fort Chiswell I-81 Corridor	Extends to Exit 80, but not Exit 77 area (wells are low yield).	Extension from Fort Chiswell. May need reliable centralized water source to supply future growth.
Barren Springs	System limited to 65 connections. Well development difficult.	
Town of Wytheville	Existing system adequate. Leakage problems.	Consider development of alternate source in Sand Mountain area.
Town of Rural Retreat	Membrane filtration system in development for town springs.	
Rte. 11 east to Wytheville	Problems with quality, contamination and low quantity.	
Rte. 11 west of Rural Retreat (and into Smyth County)	Up to 800 people lack public water.	
Speedwell	System adequate. Leakage problem needs attention.	
Rte. 21 (south of Wytheville)	Very low quantities of water, and sometimes no water.	Consider extension from Wytheville along Rte. 21.

The east planning area includes the I-77/81 corridor near Fort Chiswell. This area is growing and needs more source capacity, storage capacity and distribution improvements. Rapid growth projected for **Fort Chiswell**. Repairs needed at Austinville. **Poplar Camp** a potential growth area. Growth also likely due to VDOT upgrades to Rte. 94 and Rte. 610. Recreational development possible for **Fosters Falls** area.

The north central planning area includes Town of Wytheville and area just north of town. Most growth will occur in **Wytheville**, and the existing system is adequate to support growth. Area north of town is mountainous forest and is sparsely populated.

The northwest planning area includes **Town of Rural Retreat** and **I-81/Route 11 corridor** to Wytheville. Considerable growth projected for this area. The southwest planning area includes the Speedwell area. Cripple Creek and Cedar Springs may one day need public water if concentrated growth continues in these areas.

Table No. 14A: Flood Mitigation Details for Bland, Carroll, Grayson Counties and Localities
Average Values of Flood-Prone Land, Improvements, Square Footage, Mitigation Cost Estimates

							Mitigation Cost Estimates		
		1	2	3	4	5	6	7	8
Locality	**Class of Property**	**Avg. Value: Land**	**Avg. Value: Improvmts**	**Avg. Total (Cols. 1+2)**	**Avg. Sq. Footage**	**Avg. Cost: Elevation**	**Avg. Cost: Reloc. (Col. 3x1.5)**	**Avg. Cost: Demolish**	**Avg. Total (Cols. 6+7)**
Bland County									
Bastian area	Resid.	SF homes	NA	$48,804	1,400	$57,400	$73,206	$5,000	$78,206
		Mobile homes	NA	NA	NA	NA	$40,000	NA	$40,000
Bland area	Resid.		NA	$48,804	1,400	$57,400	$73,206	$5,000	$78,206
Rocky Gap area	Resid.	SF homes	NA	$48,804	1,400	$57,400	$73,206	$5,000	$78,206
		Mobile homes	NA	NA	NA	NA	$40,000	NA	$40,000
Carroll County									
Town of Hillsville	Not applicable. There is no significant development in the floodplain.								
Grayson County									
Town of Fries	Not applicable. There is no significant development in the floodplain.								
Town of Independence	Not applicable. There is no significant development in the floodplain.								
Town of Troutdale	Not applicable. There is no identified floodplain within town limits.								

Notes:
Value of land and improvements in Bland County based on average of tax-appraised values.
Elevation cost estimate based on $41/square foot, as suggested by a consultant who works in flood mitigation.
Relocation estimate includes 25% to estimate current market values and another 25% for relocation costs.
Demolition costs based on square footage range (residential only): up to 1,000 sf, $4,000; 1,000-1,500 sf, $4,500; 1,500-2,500 sf, $5,500; 2,500-3,500, $7,000.

Table No. 15A: Flood Mitigation Details for Smyth County
Average Values of Flood-Prone Land, Improvements, Square Footage, Mitigation Cost Estimates

						Mitigation Cost Estimates			
		1	2	3	4	5	6	7	8
Locality	**Class of Property**	**Avg. Value: Land**	**Avg. Value: Improvmts**	**Avg. Total (Cols. 1+2)**	**Avg. Sq. Footage**	**Avg. Cost: Elevation**	**Avg. Cost: Reloc. (Col. 3X1.5)**	**Avg. Cost: Demolish**	**Avg. Total (Cols. 6+7)**
Smyth County									
Town of Chilhowie	Resid.	$19,870	$64,574	$84,444	2,673	$231,329	$126,666	$5,868	$132,534
	Comm.	$79,772	$635,967	$715,739	18,877	$773,962	$1,073,608		$1,073,608
	Industry	$149,600	$3,852,800	$4,002,400	131,202	$5,379,284	$6,003,600		$6,003,600
	Govmnt	$64,750	$1,670,517	$1,735,267	28,631	$1,173,862	$2,602,900		$2,602,900
	Non-Profit	$23,000	$137,080	$160,080	3,689	$151,241	$240,120	$6,700	$246,820
Town of Marion	Resid.	$7,361	$27,517	$34,878	1,917	$78,957	$52,316	$5,500	$57,816
	Comm.	$33,956	$110,923	$144,879	-		$217,319		$217,319
	Industry	$101,250	$1,409,225	$1,510,475	-		$2,265,713		$2,265,713
	Govmnt	$57,900	$339,000	$396,900			$595,350		$595,350
	Non-Profit	$9,500	$111,309	$120,809			$181,214		$181,214
Town of Saltville	Resid.	$7,847	$26,358	$34,205	1,793	$73,505	$51,308	$5,298	$56,606
	Comm.	$34,150	$330,150	$364,300	11,028	$452,172	$546,450		$546,450
	Industry	$100,900	$568,400	$669,300	55,503	$2,275,622	$1,003,950		$1,003,950
	Govmnt	$328,300	$2,408,733	$2,737,033	44,786	$1,836,235	$4,104,550		$4,104,550
	Non-Profit								
Sugar Grove area	Resid.	$14,990	$30,890	$45,608	1,620	$66,420	$68,411	$5,038	$73,449
	Comm.	$31,500	$13,500	$45,000	960	$39,371	$67,500	$4,000	$71,500
	Non-Profit	$13,500	$75,815	$89,315	2,481	$101,732	$133,973	$6,000	$139,973

Notes:
Value of land and improvements based on tax-appraised values.
Elevation cost estimate based on $41/square foot, as suggested by a consultant who works in flood mitigation.
Relocation estimate includes 25% to estimate current market values and another 25% for relocation costs.
Demolition costs based on square footage range (residential only): up to 1,000 sf, $4,000; 1,000-1,500 sf, $4,500; 1,500-2,500 sf, $5,500; 2,500-3,500, $7,000.

Table No. 16A: Flood Mitigation Details for Washington County
Average Values of Flood-Prone Land, Improvements, Square Footage, Mitigation Cost Estimates

						Mitigation Cost Estimates			
		1	2	3	4	5	6	7	8
Locality	**Class of Property**	**Avg. Value: Land**	**Avg. Value: Improvmts**	**Avg. Total (Cols. 1+2)**	**Avg. Sq. Footage**	**Avg. Cost: Elevation**	**Avg. Cost: Reloc. (Col. 3x1.5)**	**Avg. Cost: Demolish**	**Avg. Total (Cols. 6+7)**
Washington County									
Town of Abingdon	Resid.	$31,795	$68,629	$100,424	2,181	$89,415	$150,636	$5,870	$156,506
	Comm.	$85,744	$271,122	$356,867	21,119	$865,874	$535,300		$535,300
	Industry	$13,000	$85,100	$98,100	2,243	$91,971	$147,150		$147,150
	Govmnt	$91,160	$305,000	$396,160	3,047	$124,908	$594,240		$594,240
	Non-Profit	$77,450	$441,525	$518,975	7,091	$290,745	$778,463	$15,400	$793,863
	Other	$149,300	$217,900	$367,200	4,425	$181,421	$550,800		$550,800
Town of Damascus	Resid.	$9,530	$42,467	$51,998	1,893	$77,606	$77,997	$5,180	$83,177
	Comm.	$16,883	$138,200	$155,033	3,839	$157,413	$232,550	$5,833	$399,635
	Industry	-	-	-	-	-	-	-	-
	Govmnt	$13,000	$81,700	$94,700	3,207	$131,487	$142,050	$7,500	$149,550
	Non-Profit	$23,250	$428,500	$451,750	17,158	$703,478	$677,625	$15,000	$1,413,261
Town of Glade Spring	Resid.	$8,375	$33,313	$41,688	1,343	$55,048	$62,531	$4,563	$67,094
	Comm.	$13,250	$22,263	$35,513	3,109	$127,454	$53,269	$7,813	$59,706
	Industry	-	-	-	-	-	-	-	-
	Govmnt	$16,500	$50,850	$67,350	8,349	$342,289	$101,025	$17,000	$104,525
	Non-Profit	$11,500	$89,450	$100,950	3,813	$156,333	$151,425	$9,750	$157,675

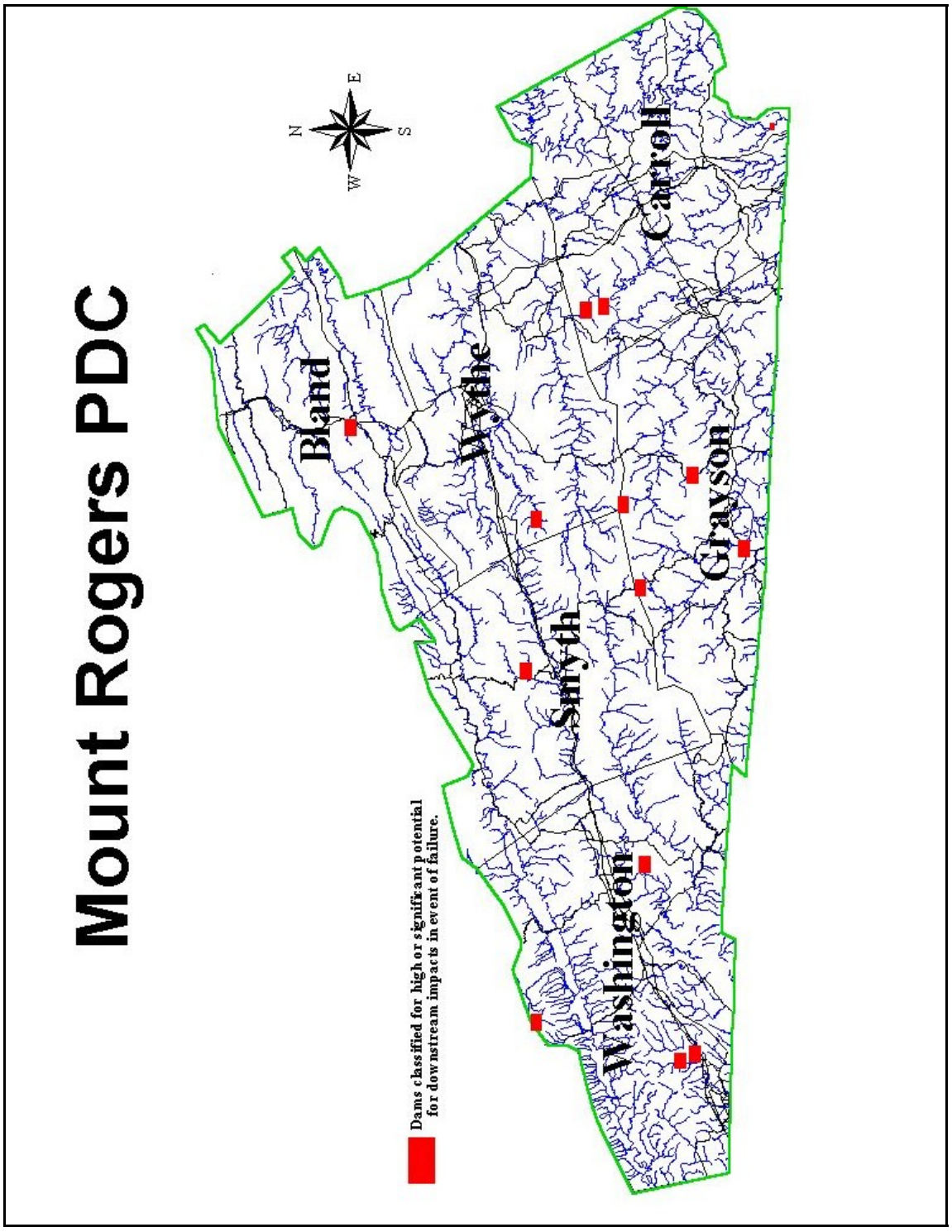
Notes:
Value of land and improvements based on tax-appraised values.
Elevation cost estimate based on $41/square foot, as suggested by a consultant who works in flood mitigation.
Relocation estimate includes 25% to estimate current market values and another 25% for relocation costs.
Demolition costs based on square footage range (residential only): up to 1,000 sf, $4,000; 1,000-1,500 sf, $4,500; 1,500-2,500 sf, $5,500; 2,500-3,500, $7,000.

Table No. 17A: Flood Mitigation Details for Wythe County and Cities of Bristol and Galax
Average Values of Flood-Prone Land, Improvements, Square Footage, Mitigation Cost Estimates

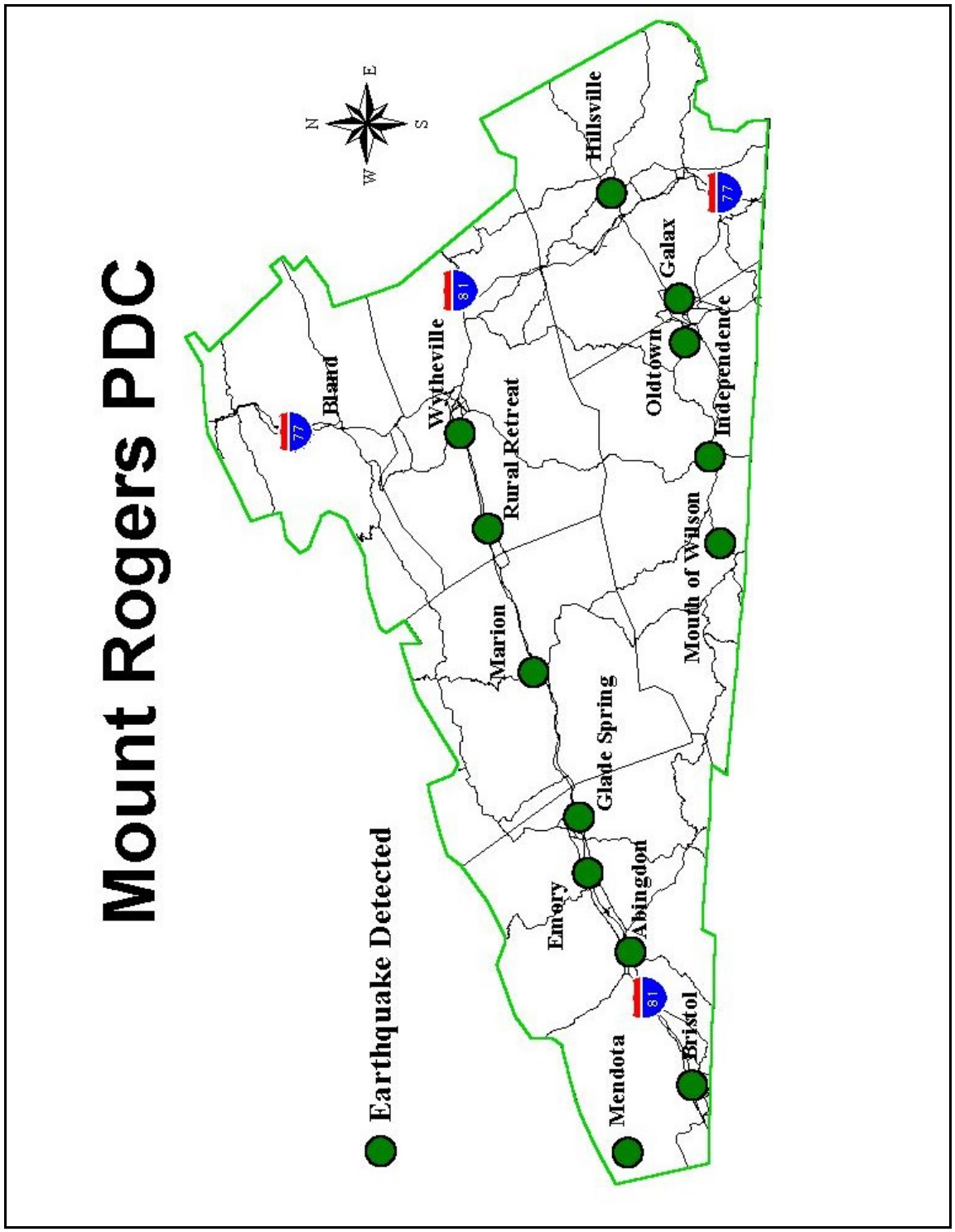
							Mitigation Cost Estimates		
		1	2	3	4	5	6	7	8
Locality	**Class of Property**	**Avg. Value: Land**	**Avg. Value: Improvmts**	**Avg. Total (Cols. 1+2)**	**Avg. Sq. Footage**	**Avg. Cost: Elevation**	**Avg. Cost: Reloc. (Col. 3x1.5)**	**Avg. Cost: Demolish**	**Avg. Total (Cols. 6+7)**
Wythe County									
Town of Rural Retreat	Not applicable. There is no identified floodplain in Rural Retreat.								
Town of Wytheville	Resid.	NA	NA	$48,804	1,917	$78,597	$73,206	$5,000	$78,206
	Comm.	NA	NA	$295,389					
	Industry	NA	NA	-					
	Govmnt	NA	NA	$904,568					
	Non-Profit	NA	NA	$223,097					
City of Bristol	We did not attempt to do separate estimates because this would only duplicate the work of the U.S. Army Corps of Engineers. Both Bristols, in Virginia and Tennessee, have made commitments to structural improvements designed to reduce flood impacts. Most of the mitigations are recommended for the Bristol, TN side along Beaver Creek. The USACE calculated expected average annual flooding damages at $3.9 million along Beaver Creek.								
City of Galax	Resid.	NA	NA	$48,804	$1,917	$78,597	$73,206	$5,000	$78,206
	Mobile homes	NA	NA	NA					
	Industry	NA	NA						

Notes:
Value of land and improvements based on tax-appraised values.
Elevation cost estimate based on $41/square foot, as suggested by a consultant who works in flood mitigation.
Relocation estimate includes 25% to estimate current market values and another 25% for relocation costs.
Demolition costs based on square footage range (residential only): up to 1,000 sf, $4,000; 1,000-1,500 sf, $4,500; 1,500-2,500 sf, $5,500; 2,500-3,500, $7,000.

Map No. 1A
Dam Locales – Mount Rogers Region

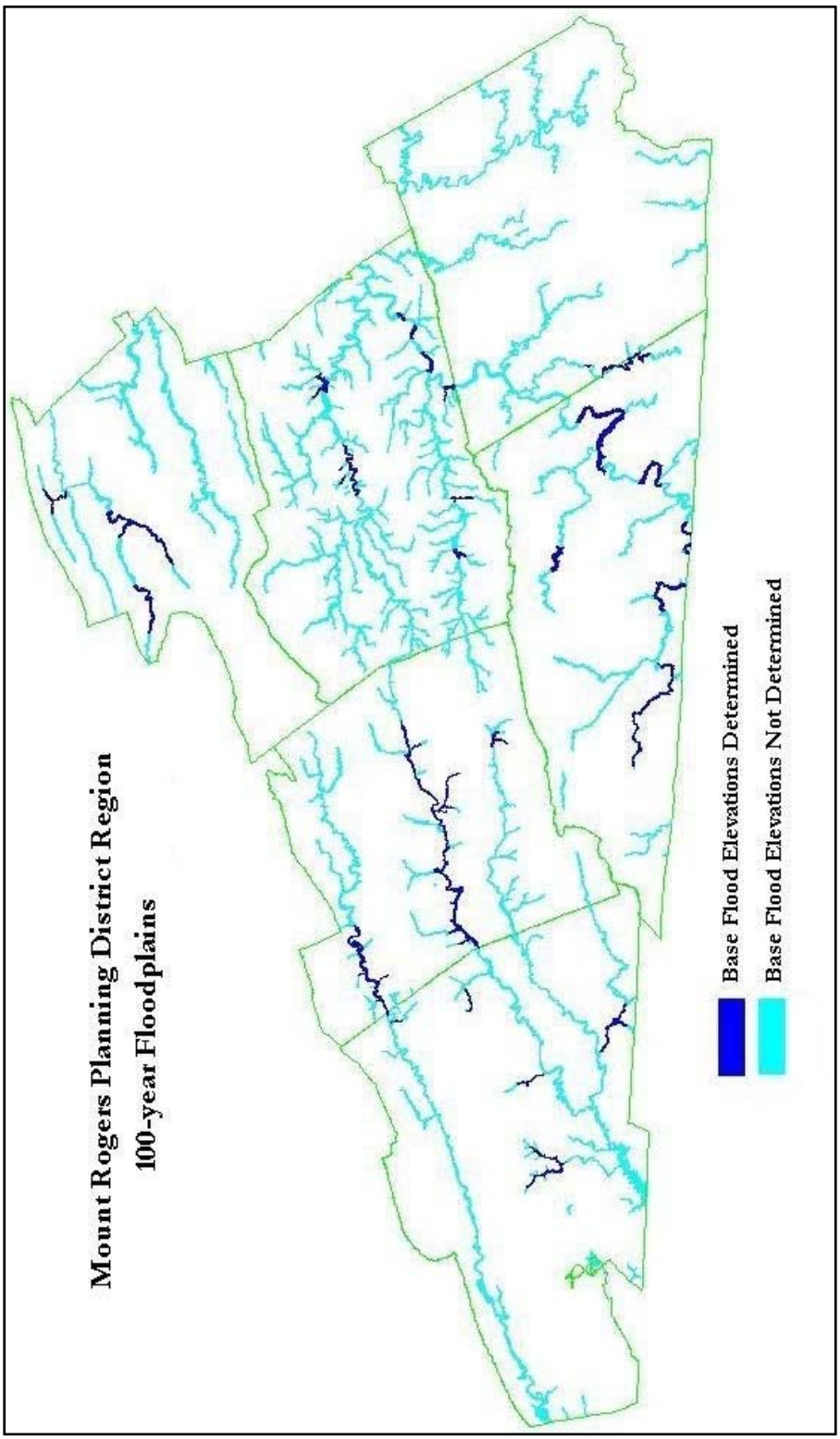


Map No. 2A
Earthquake Locales – Mount Rogers Region

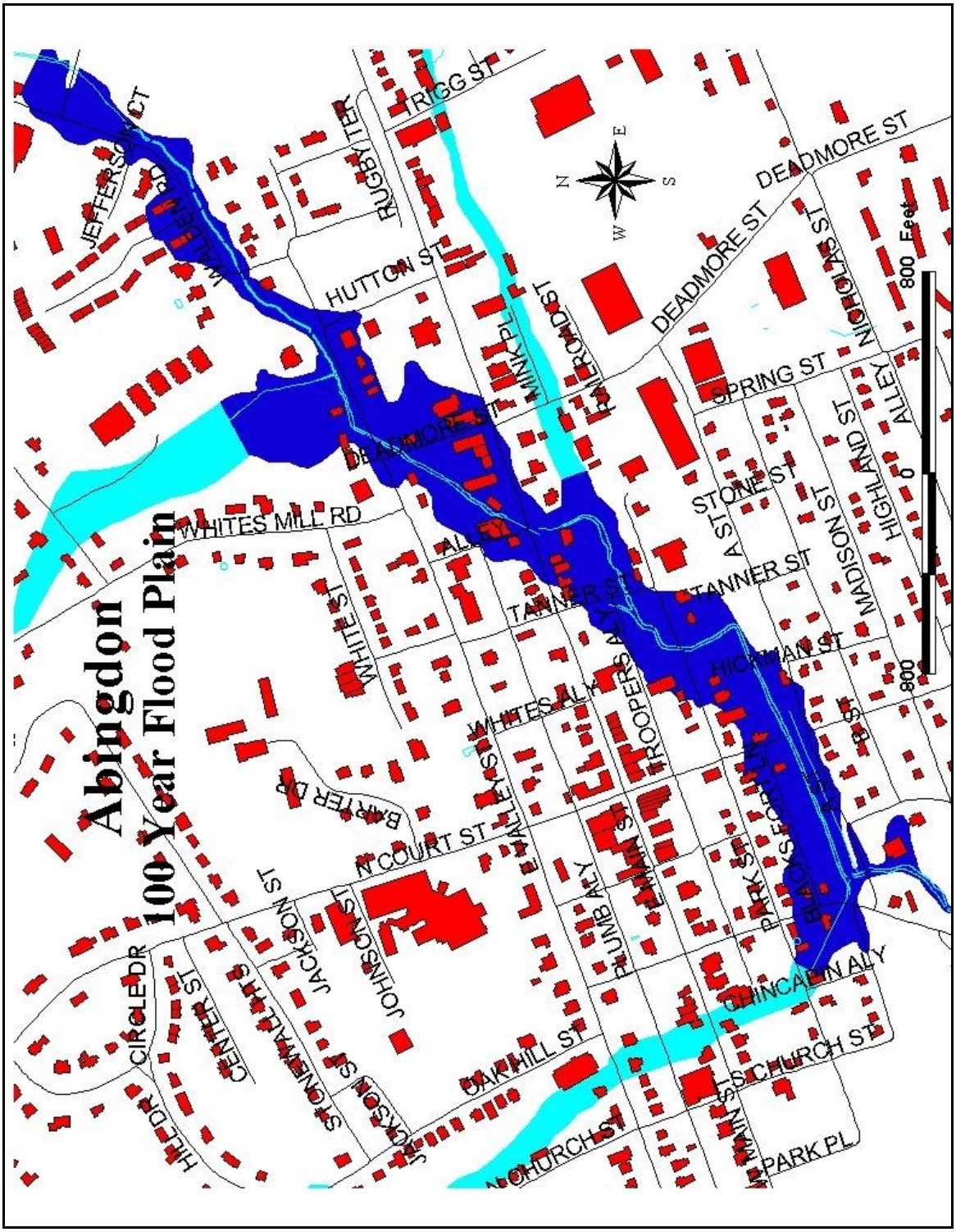


Map No. 3A
Floodplain Image – Mount Rogers Region

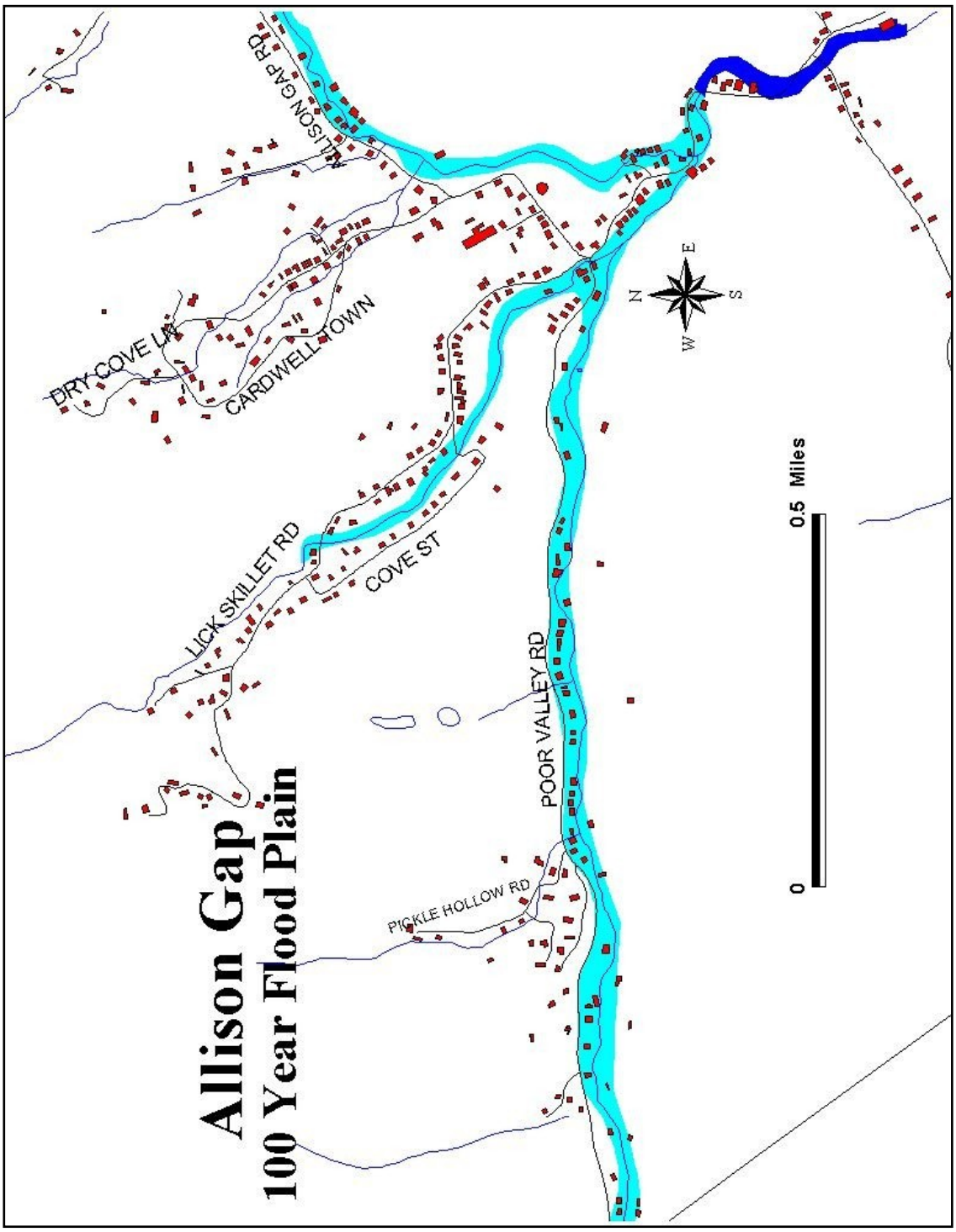
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



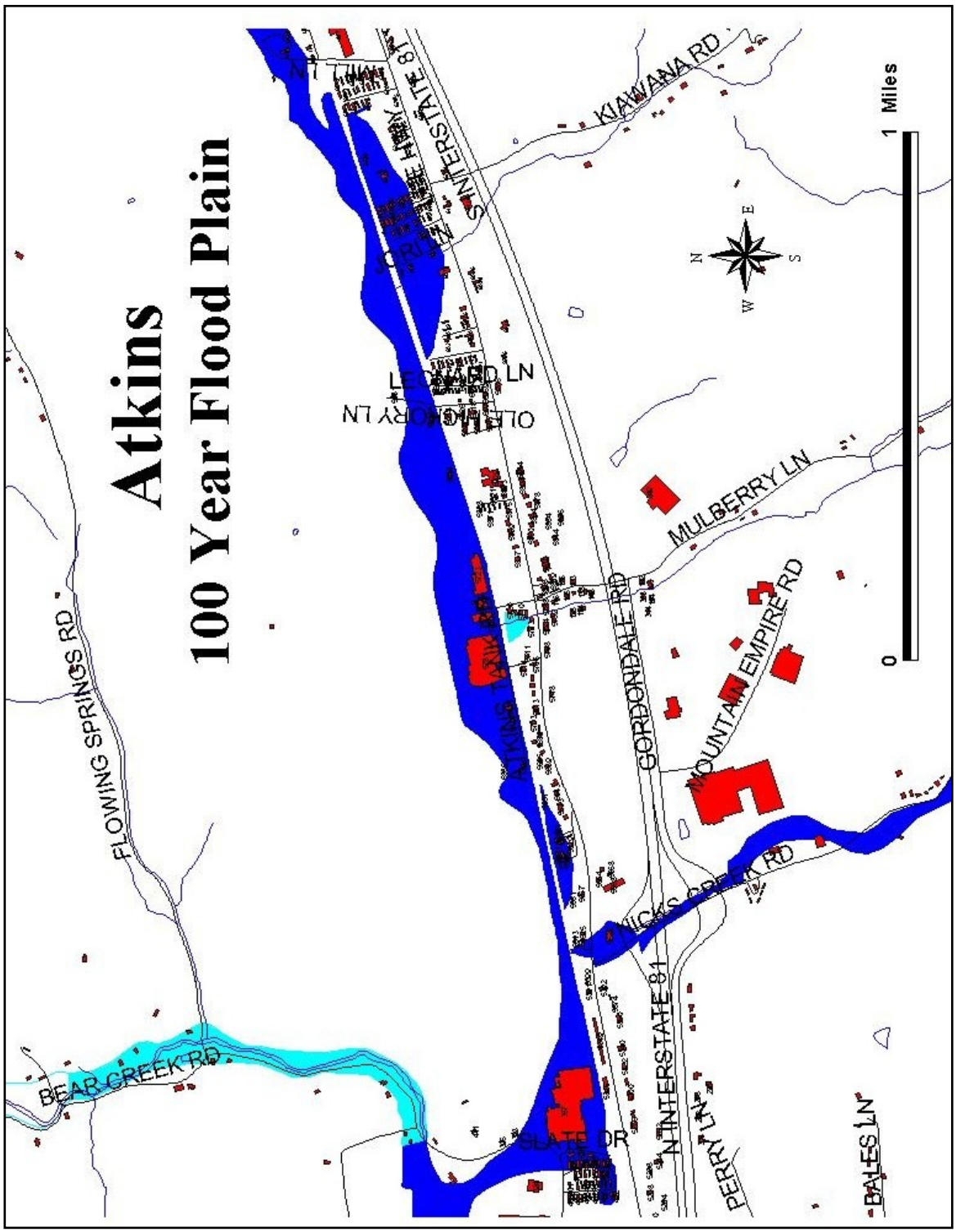
Map No. 4A
Floodplain Image – Town of Abingdon
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



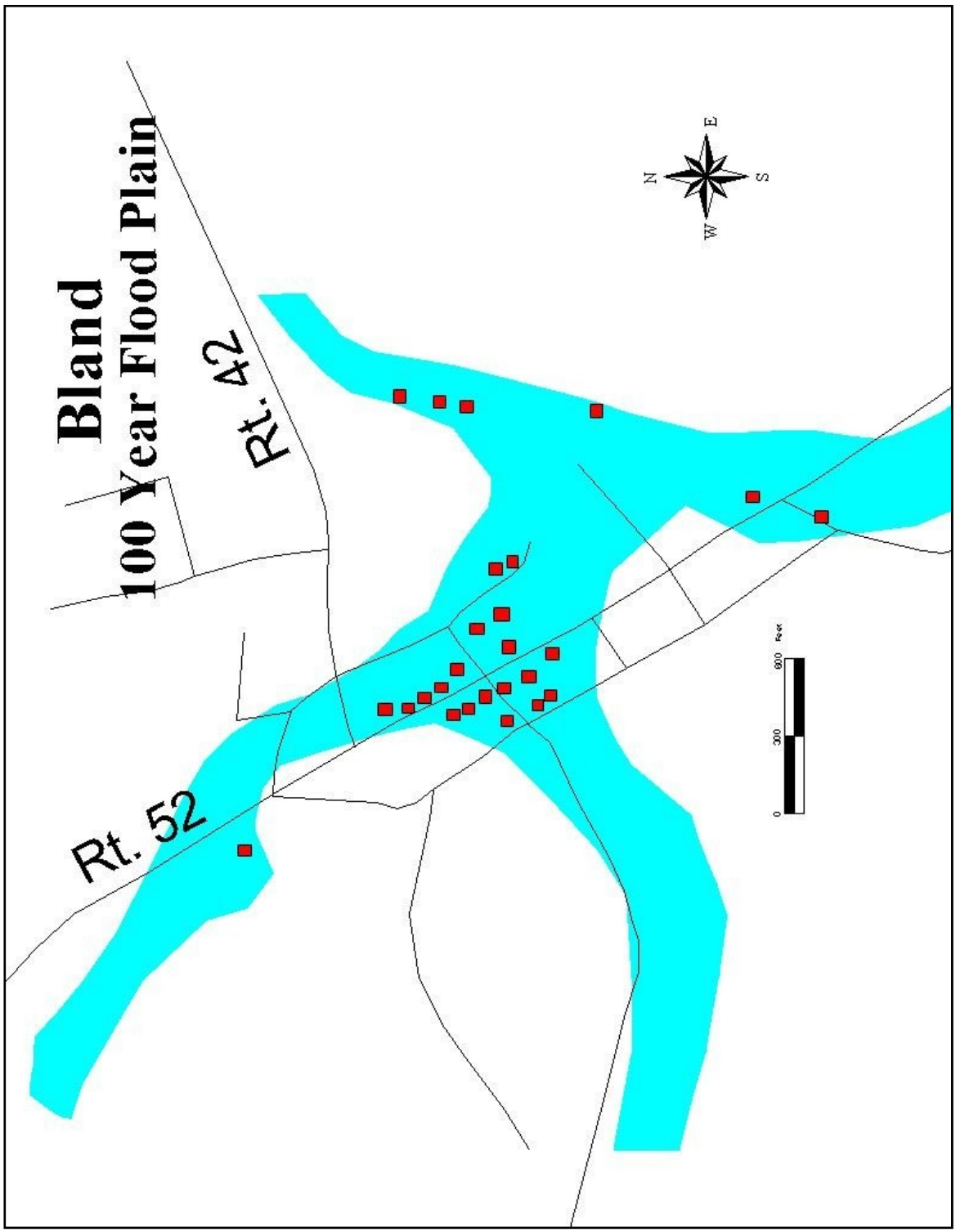
Map No. 5A
Floodplain Image – Allison Gap (near Saltville, VA)
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



Map No. 6A
Floodplain Image – Atkins Community
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



Map No. 7A
Floodplain Image – Bland Community
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



Map No. 8A
Floodplain Image – Bristol City

(Image reproduced from U.S. Army Corps of Engineers Flood Study for Bristol, TN and VA)

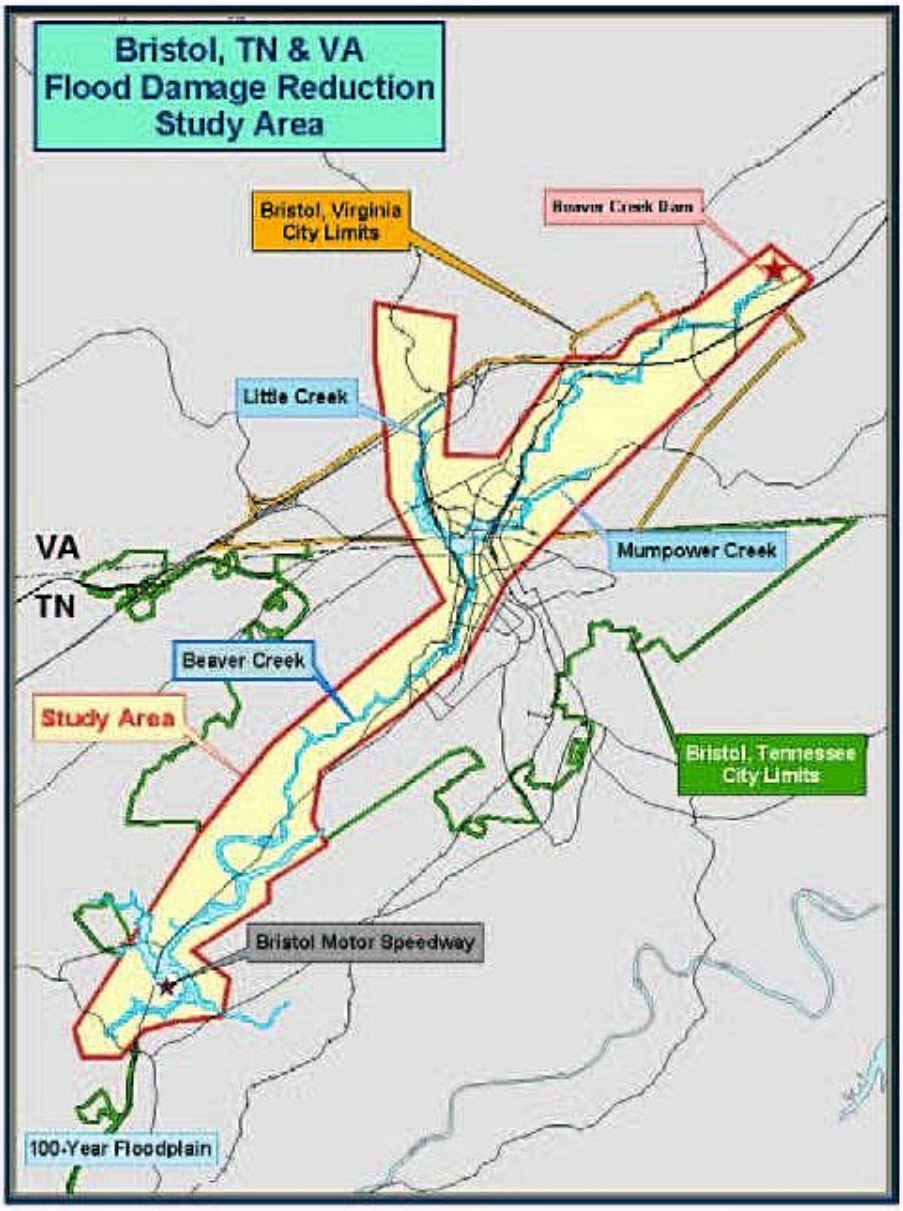
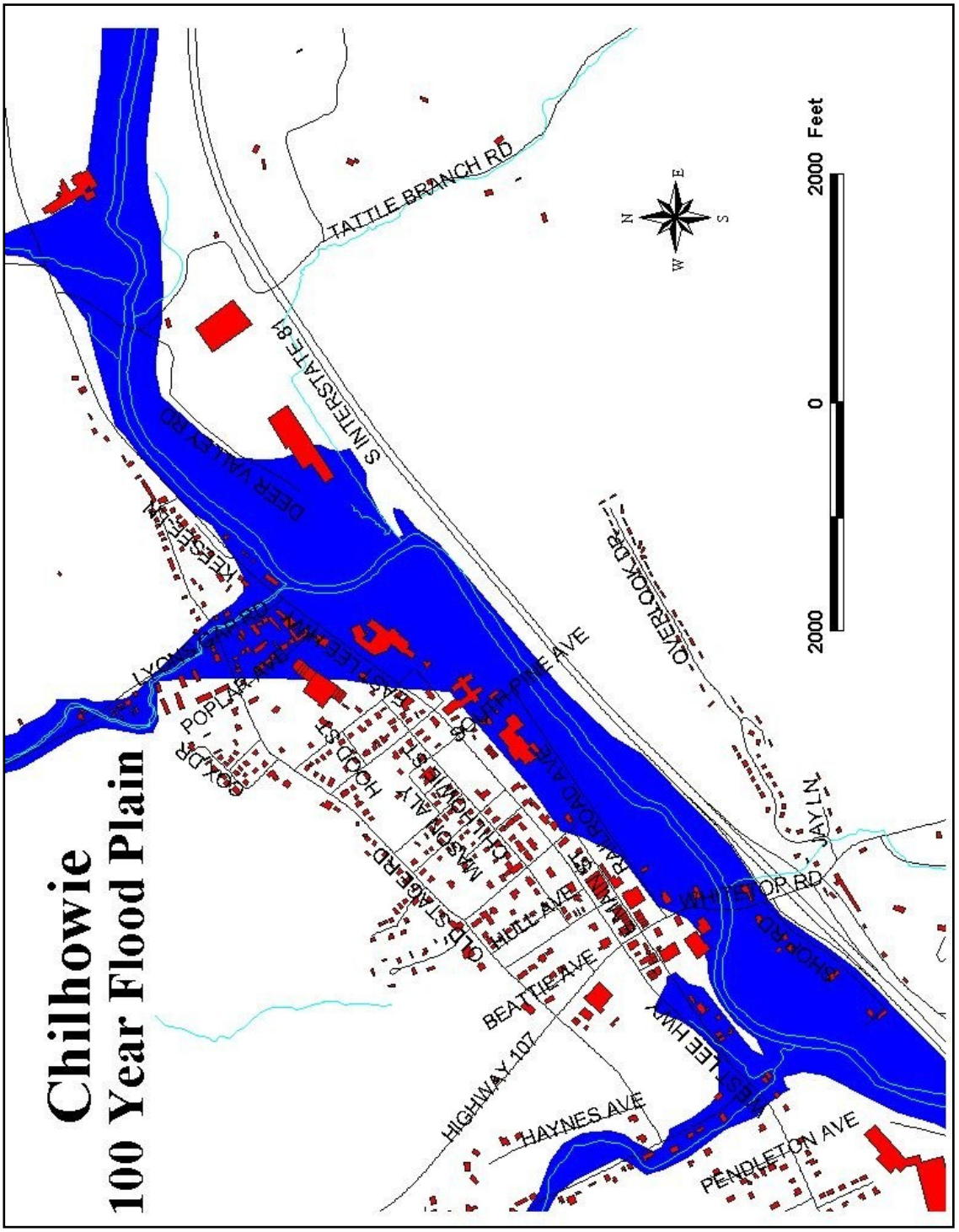
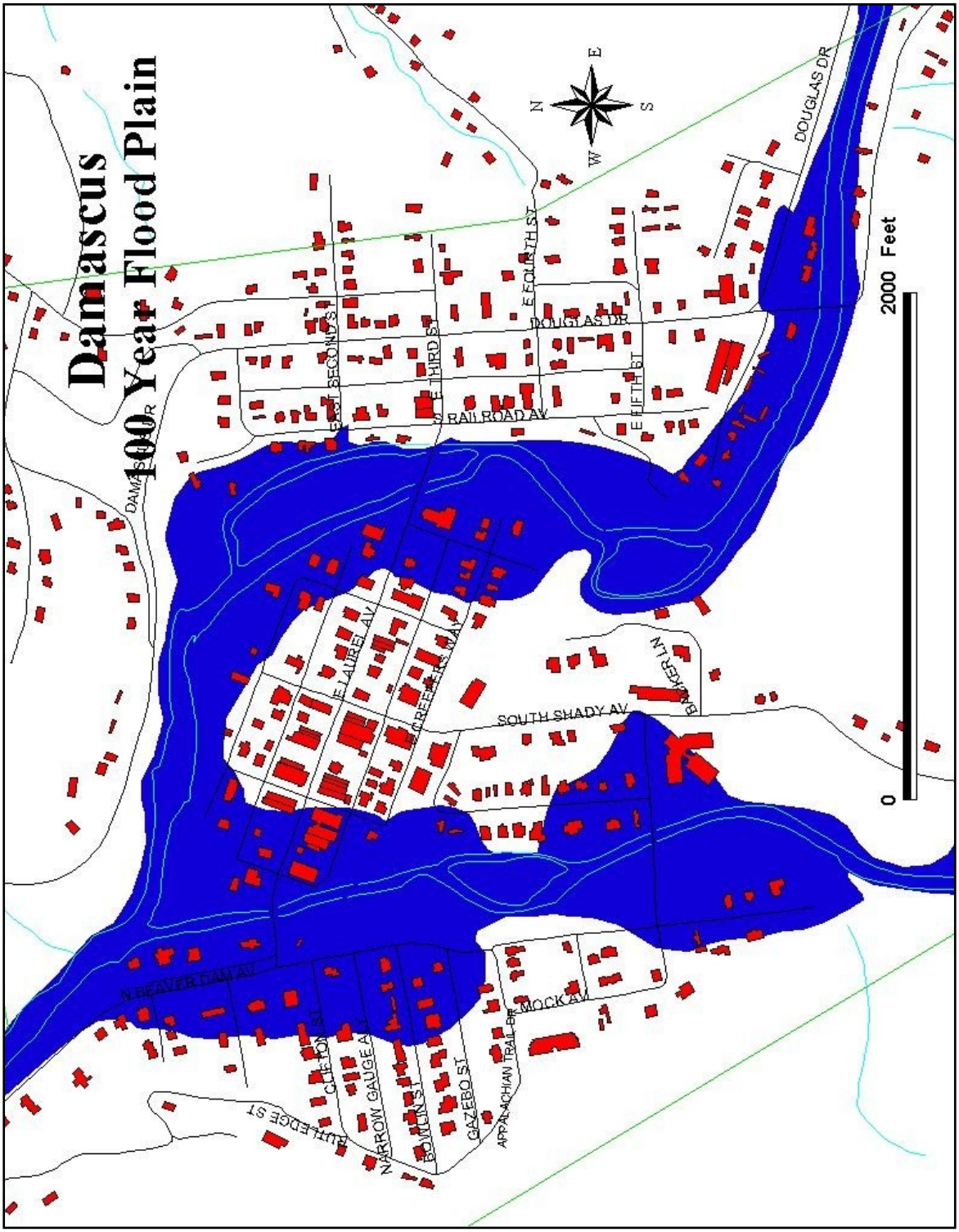


Figure 2.1 –Bristol, TN & VA Flood Damage Reduction Study Area

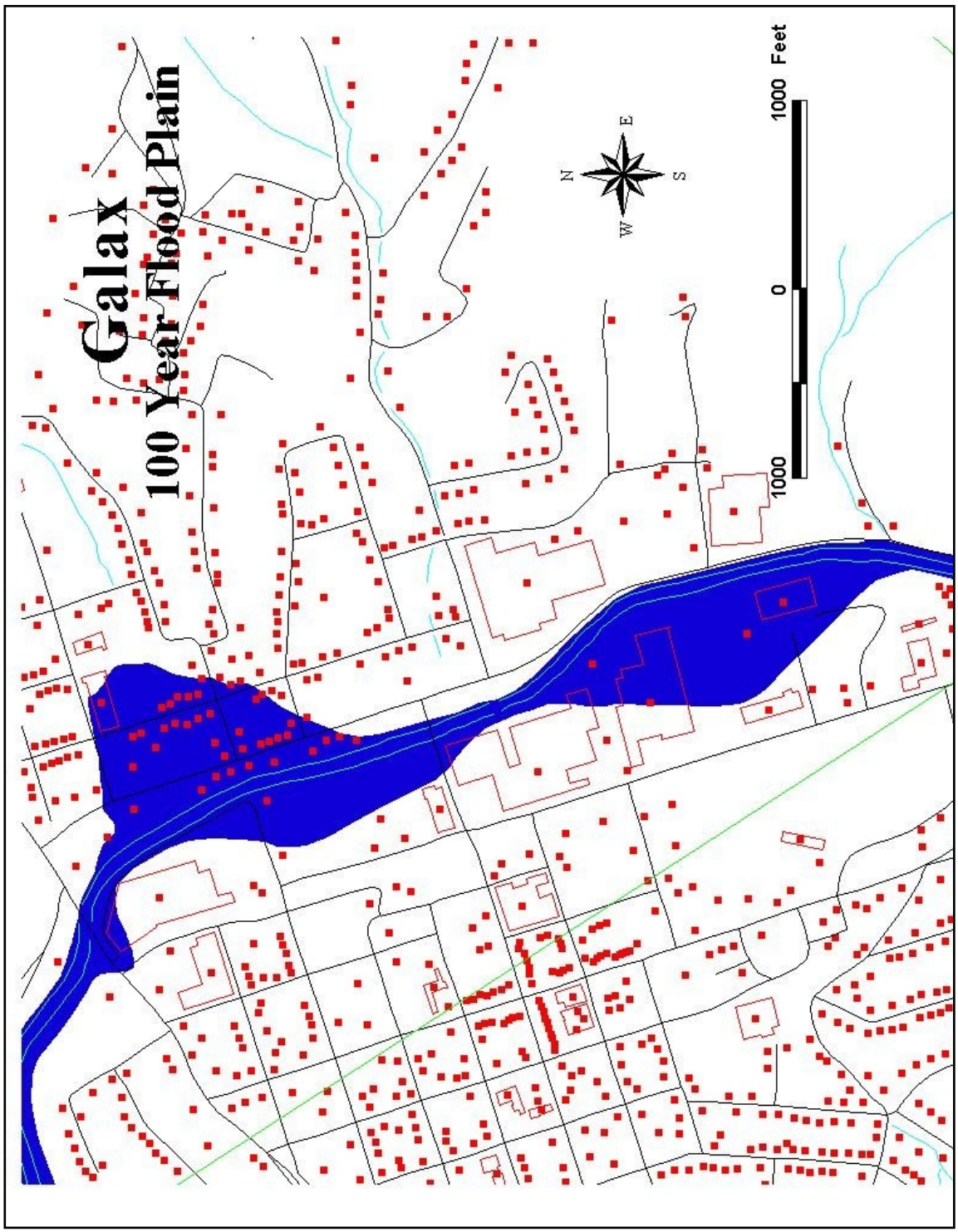
Map No. 9A
Floodplain Image – Town of Chilhowie
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



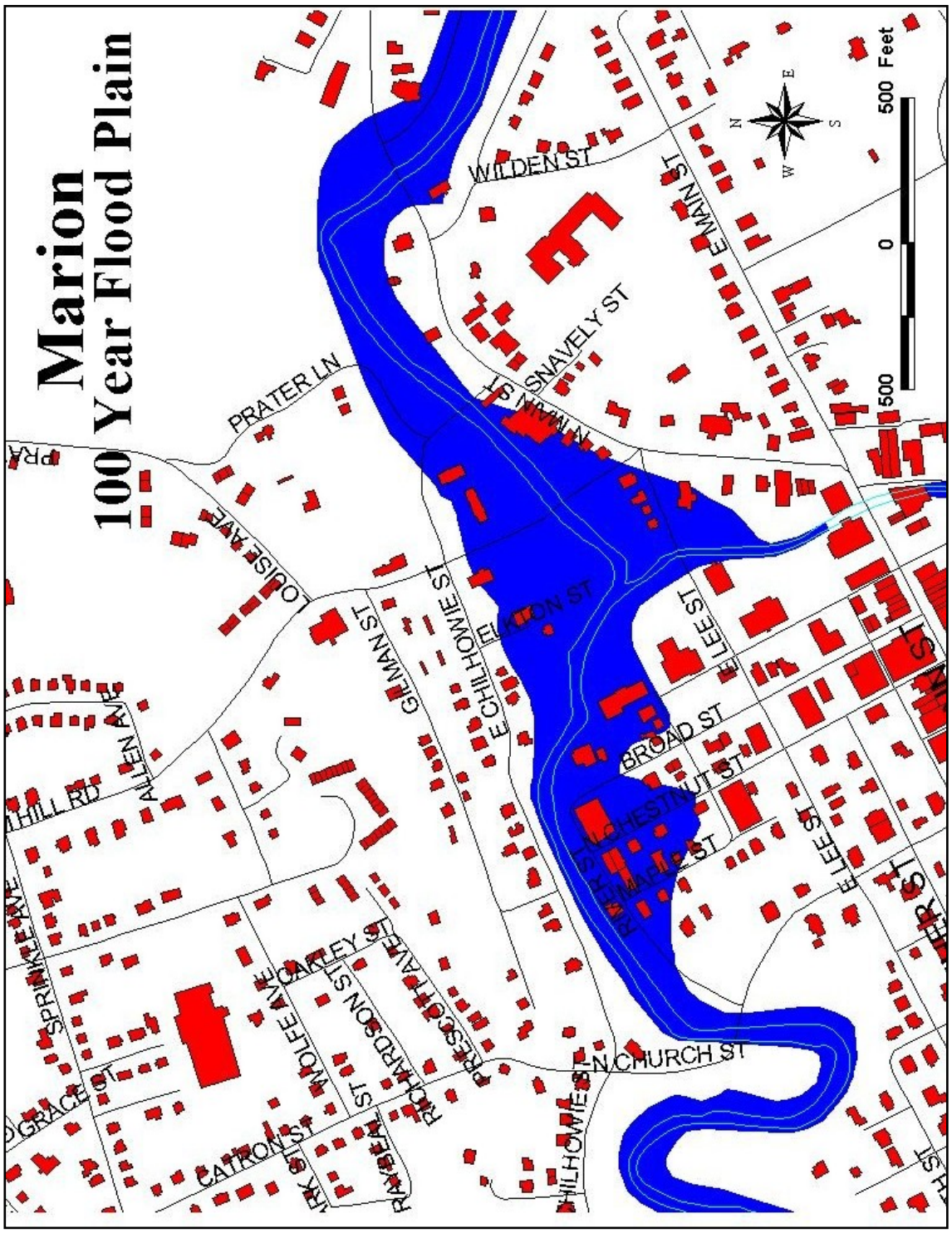
Map No. 10A
Floodplain Image – Town of Damascus
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



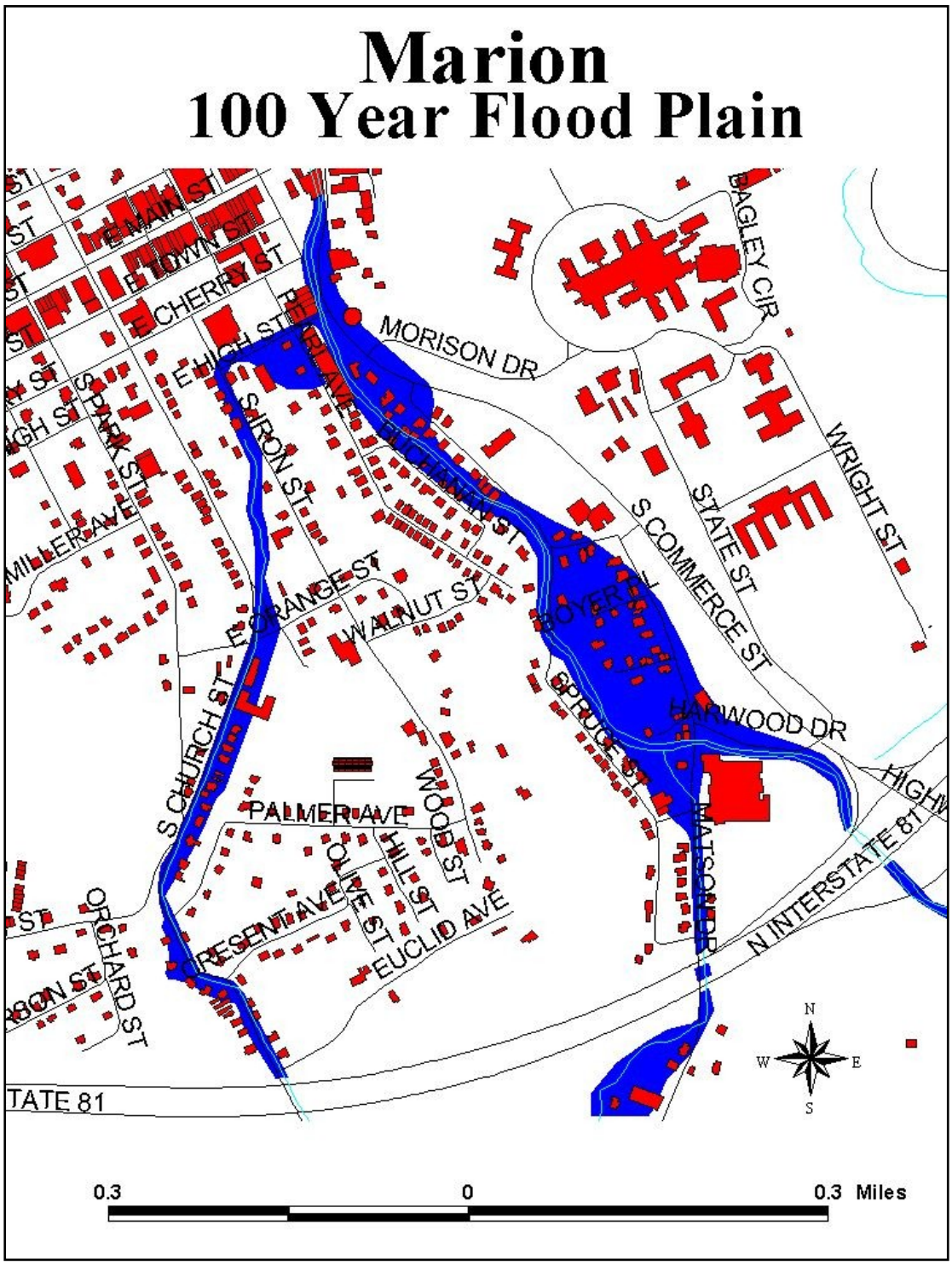
Map No. 11A
Floodplain Image – Galax City
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



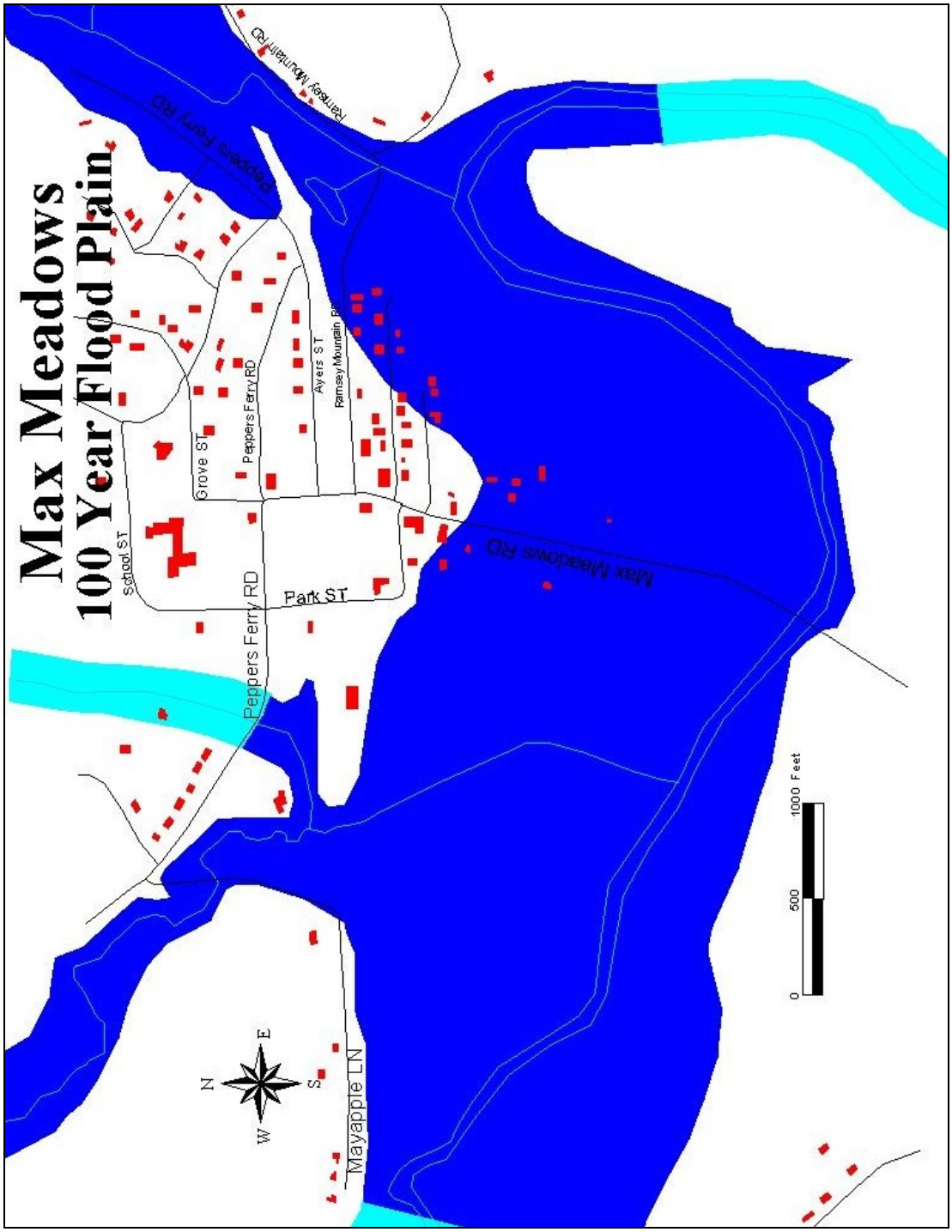
Map No. 12A
Floodplain Image – Town of Marion (north)
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



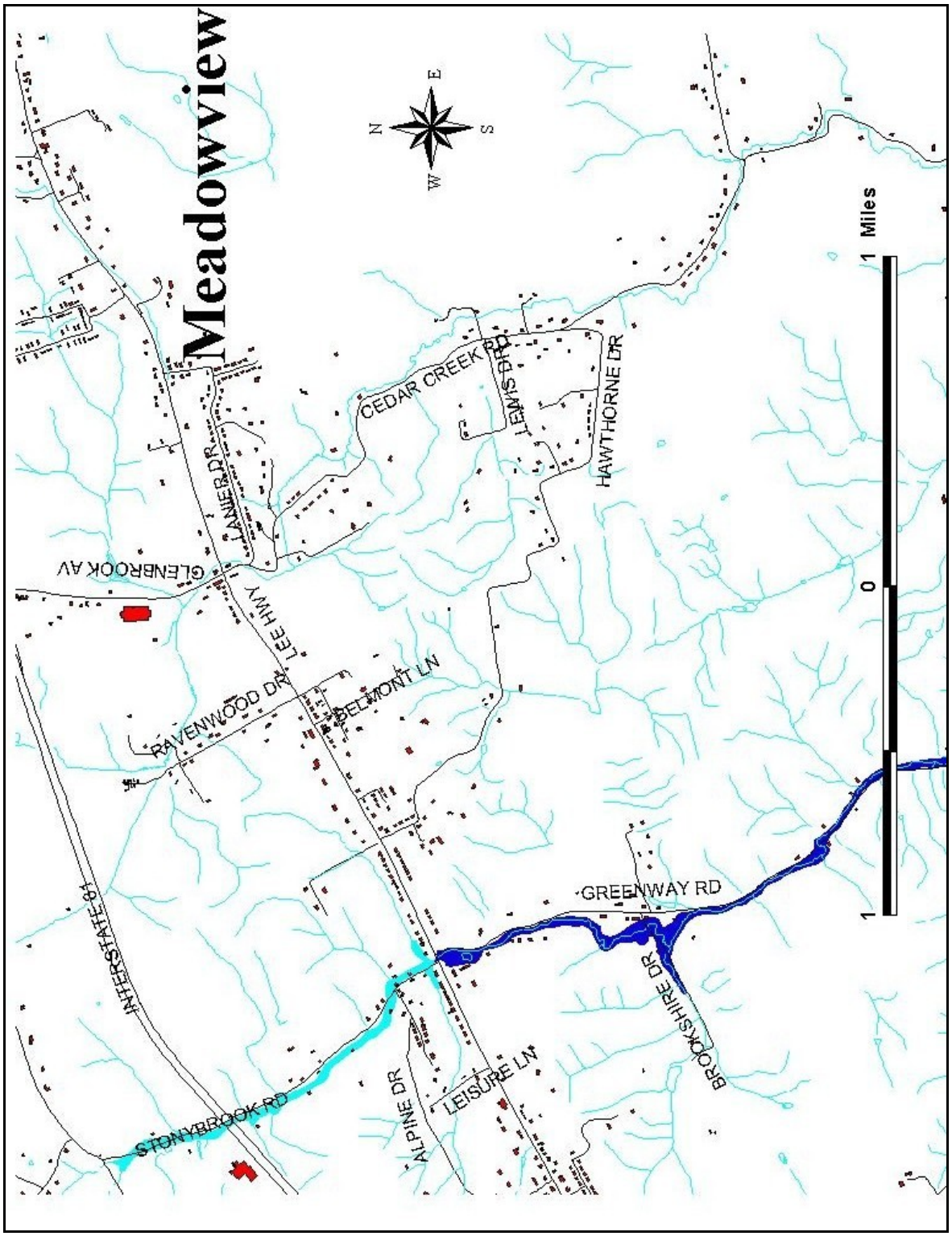
Map No. 13A
Floodplain Image – Town of Marion (south)
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



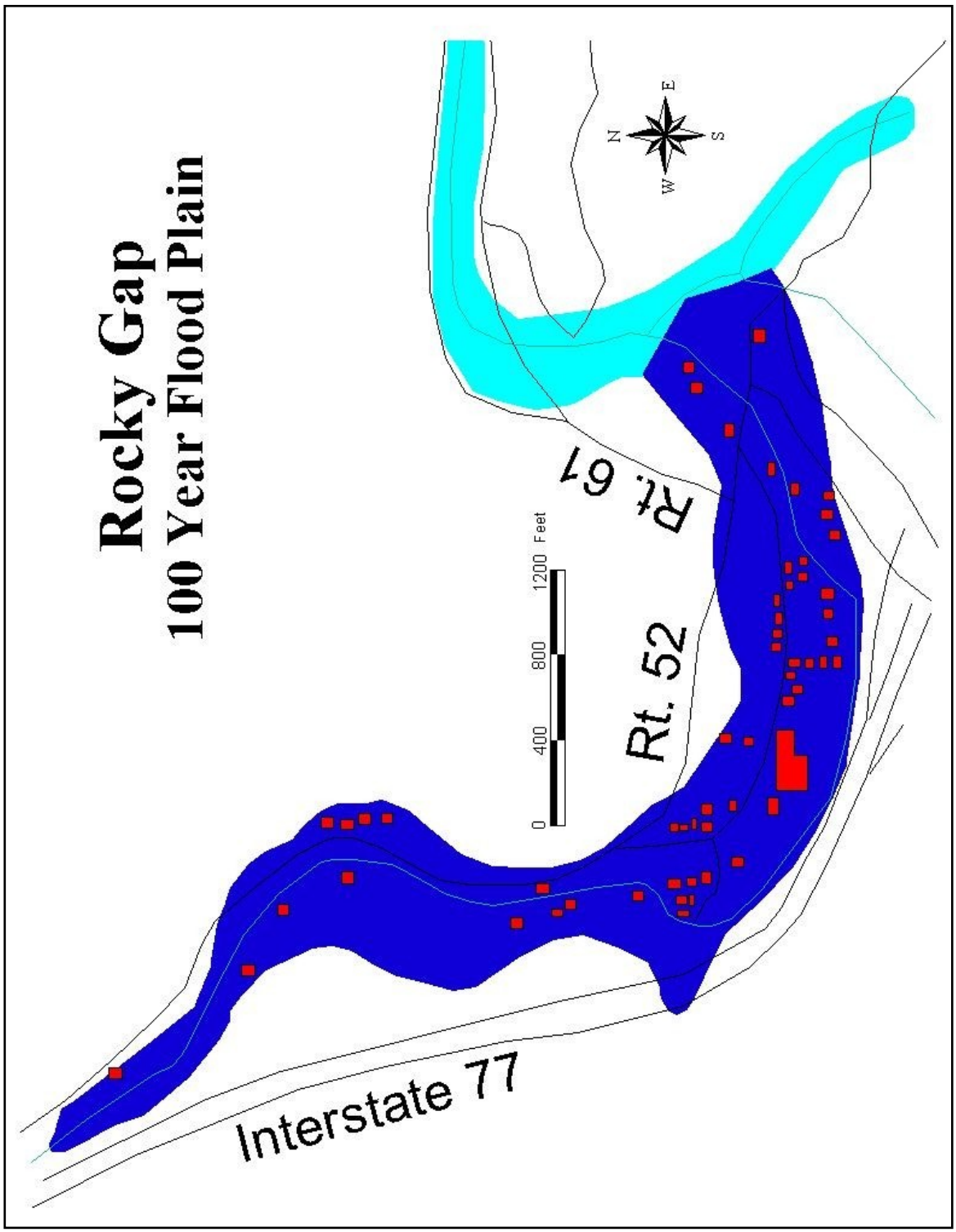
Map No. 14A
Floodplain Image – Max Meadows Community
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



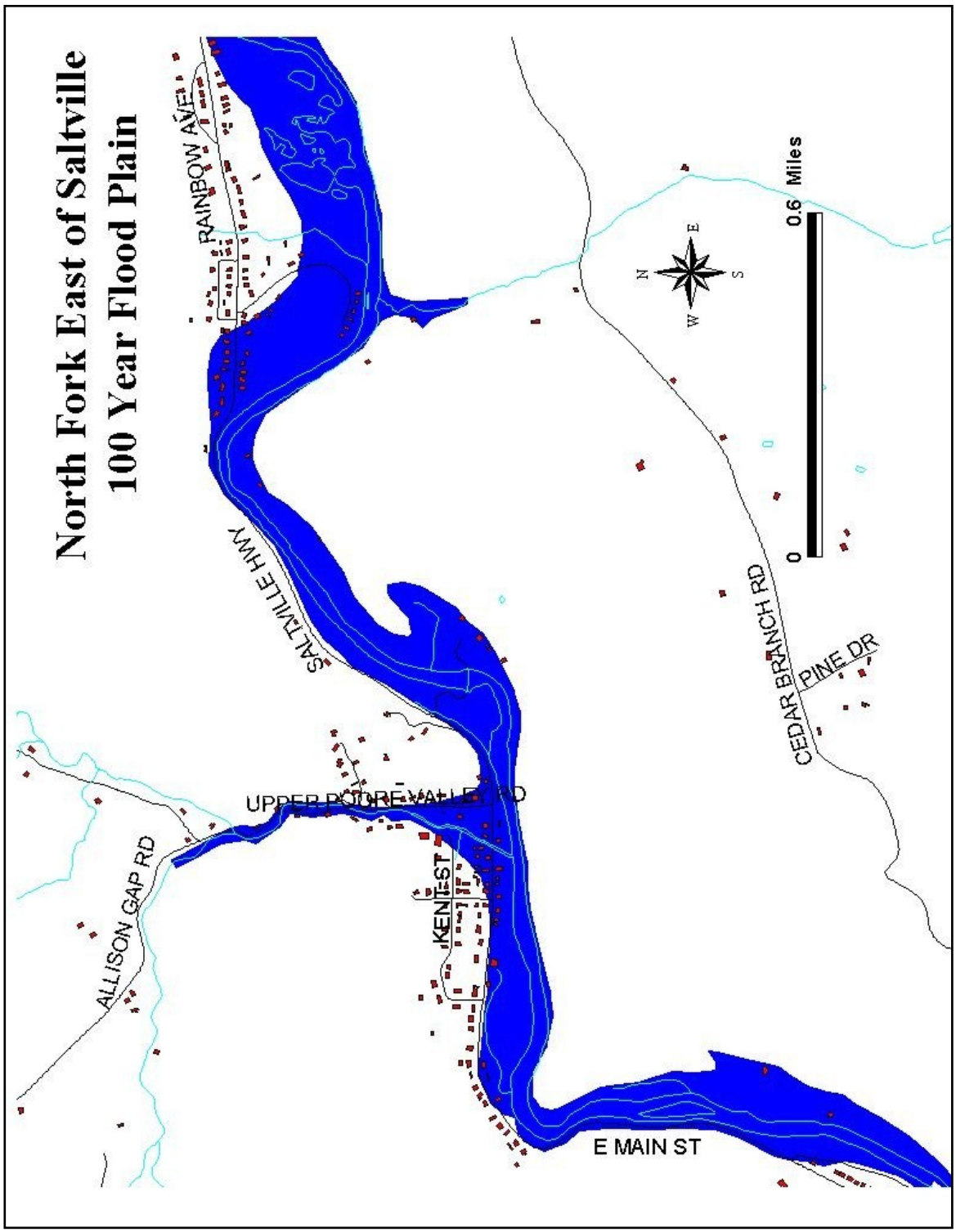
Map No. 15A
Floodplain Image – Meadowview Community
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



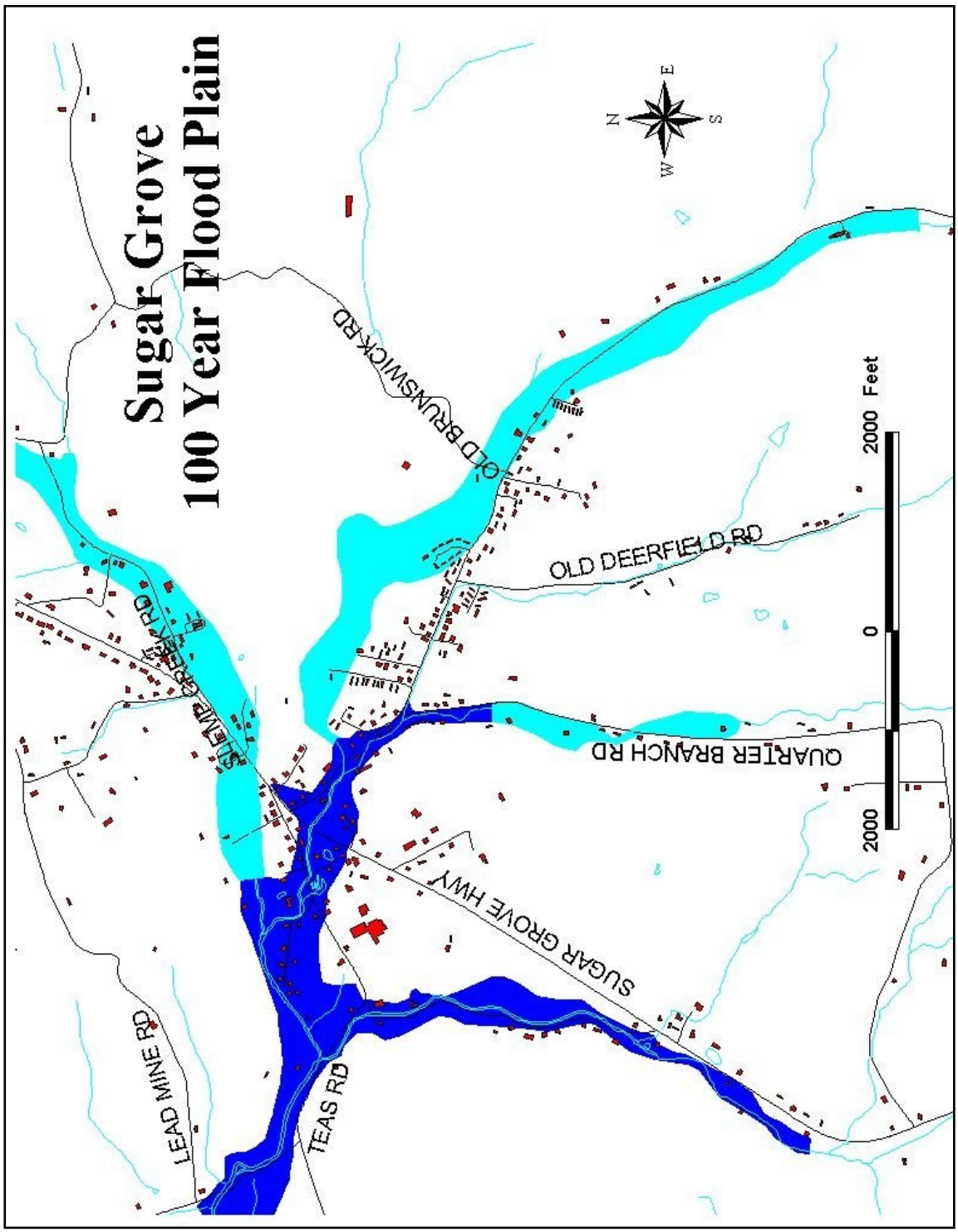
Map No. 16A
Floodplain Image – Rocky Gap Community
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



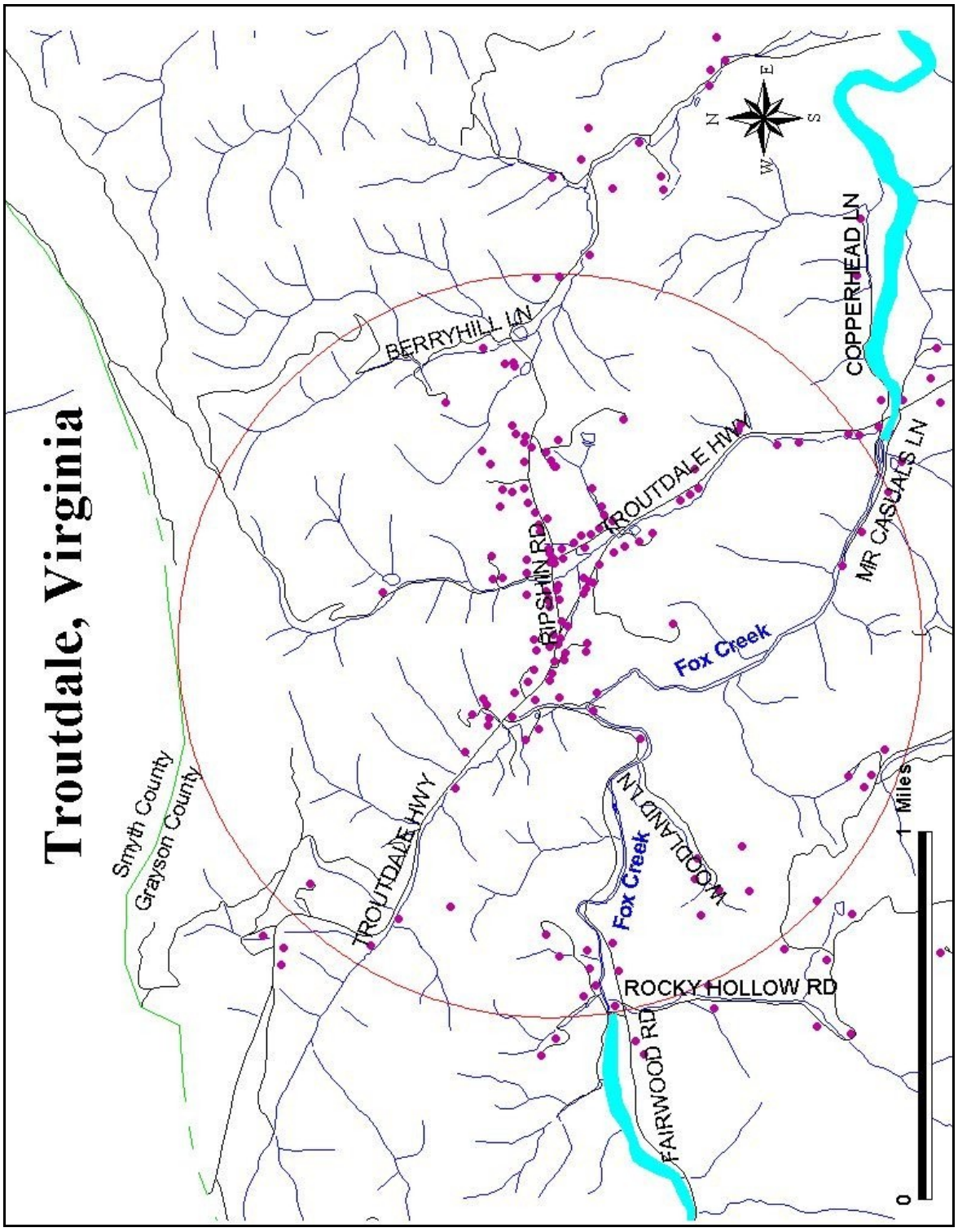
Map No. 17A
Floodplain Image – Town of Saltville (to the east)
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



Map No. 18A
Floodplain Image – Sugar Grove Community
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



Map No. 19A
Floodplain Image – Town of Troutdale
(Dark blue shows Base Flood Elevations. Aqua shows "estimated" floodplain)



Map No. 20A
Karst Region of Eastern U.S.
(Internet image from the U.S. Geological Survey)

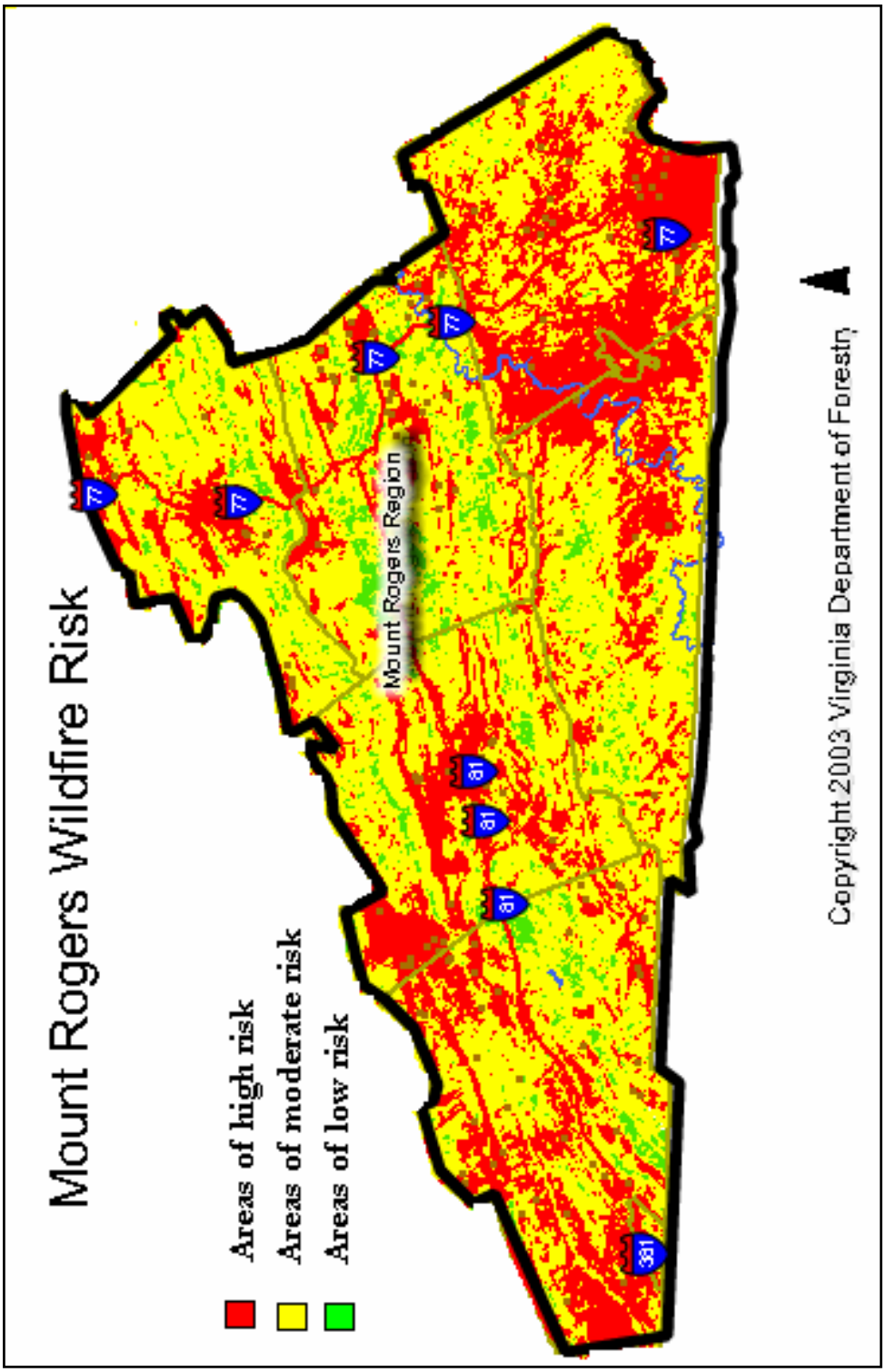
The most important aquifers in the Valley and Ridge province are northeast- to east-trending carbonate rocks. Undifferentiated sedimentary-rock aquifers that consist mostly of sandstone and yield moderate volumes of water separate the bodies of carbonate rocks. Coal-bearing beds are prominant in parts of Pennsylvania and in a local area of southeast Virginia.

EXPLANATION

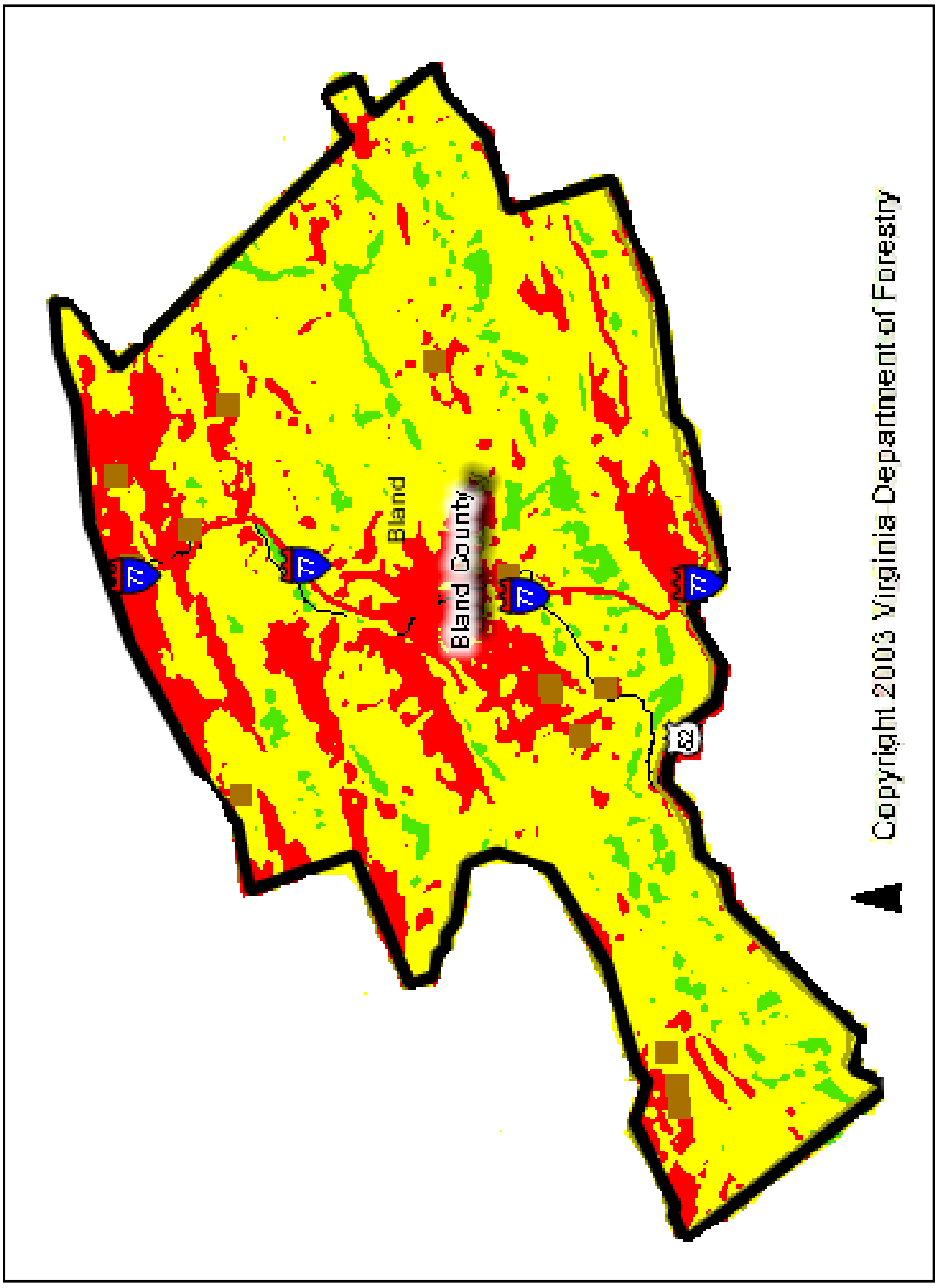
Valley and Ridge aquifers

- Carbonate-rock aquifers
- Undifferentiated sedimentary-rock aquifers

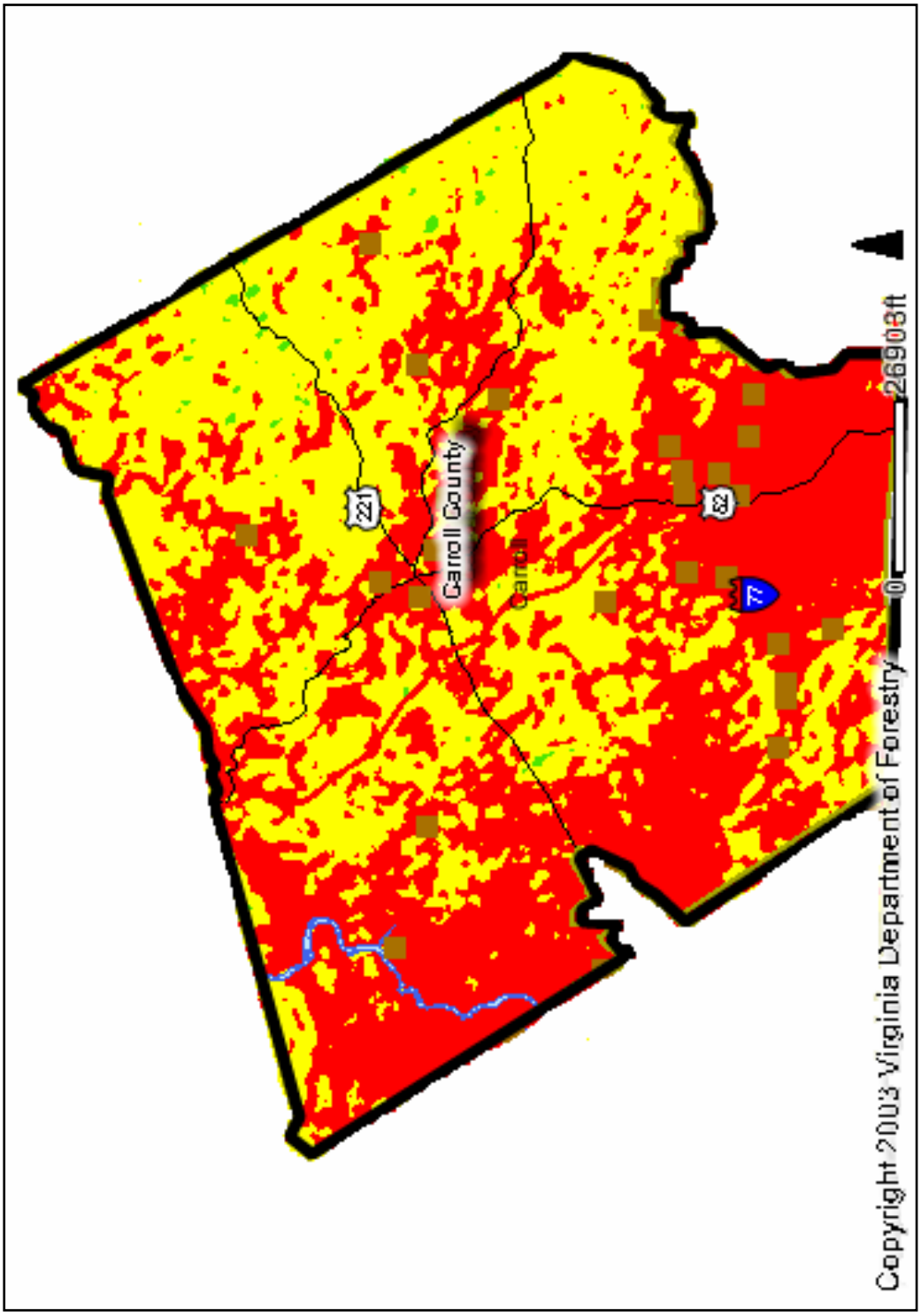
Map No. 21A
ForestRIM Image - Wildfire Risk in Mount Rogers Region



Map No. 22A
ForestRIM Image - Wildfire Risk in Bland County
(See Map No. 21A, the regional map, for meanings of the different colors in the map)

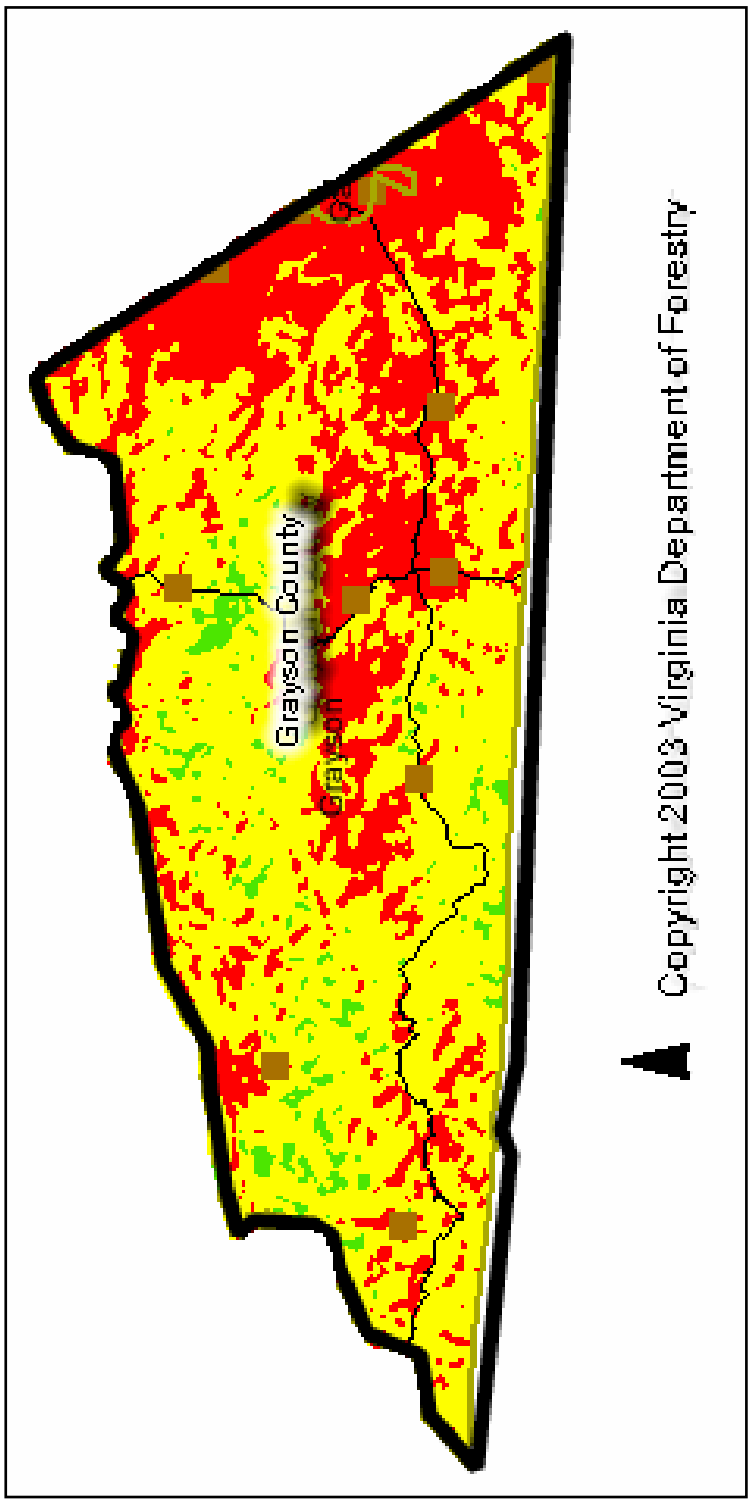


Map No. 23A
ForestRIM Image - Wildfire Risk in Carroll County
(See Map No. 21A, the regional map, for meanings of the different colors in the map)

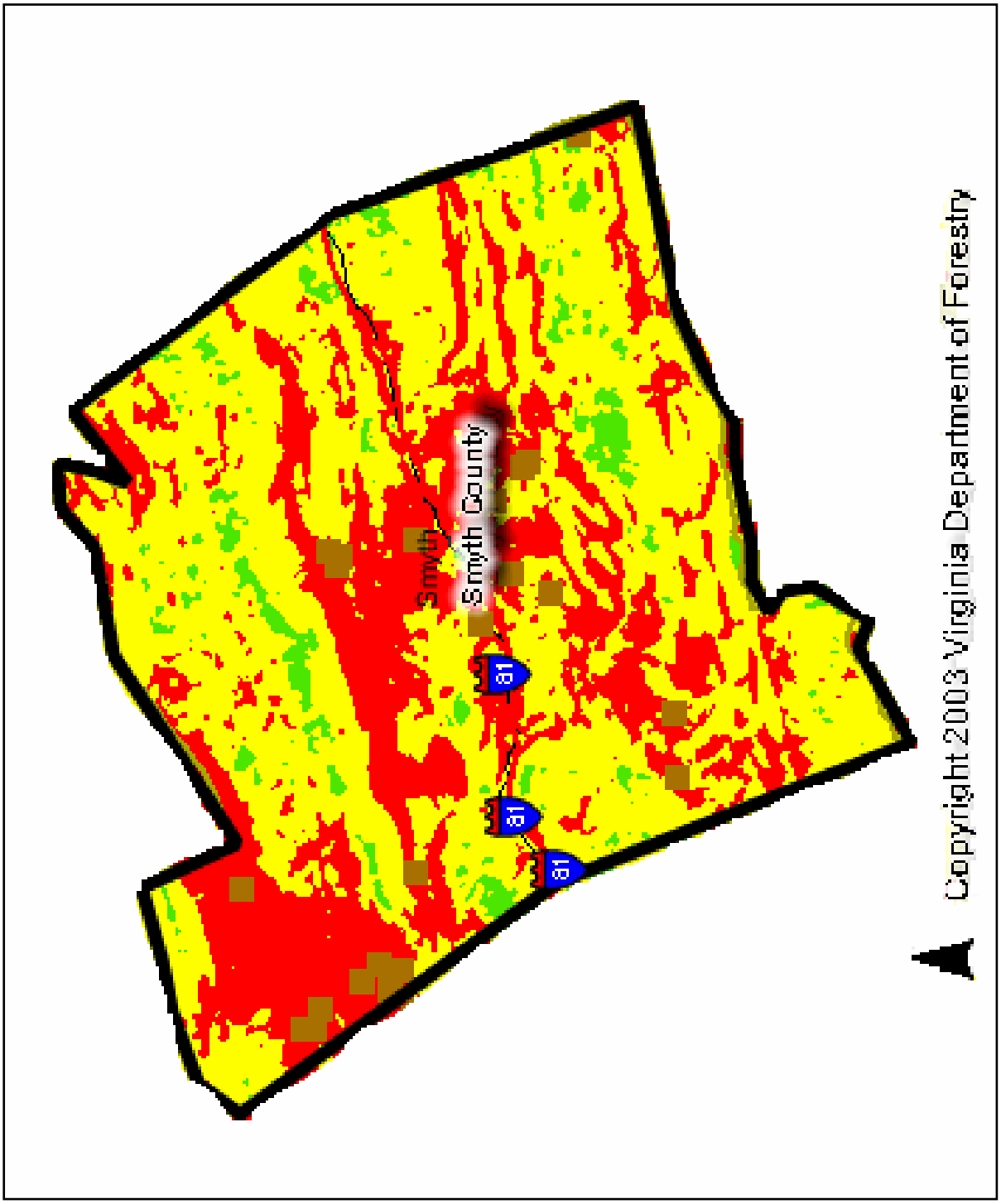


Map No. 24A
ForestRIM Image - Wildfire Risk in Grayson County

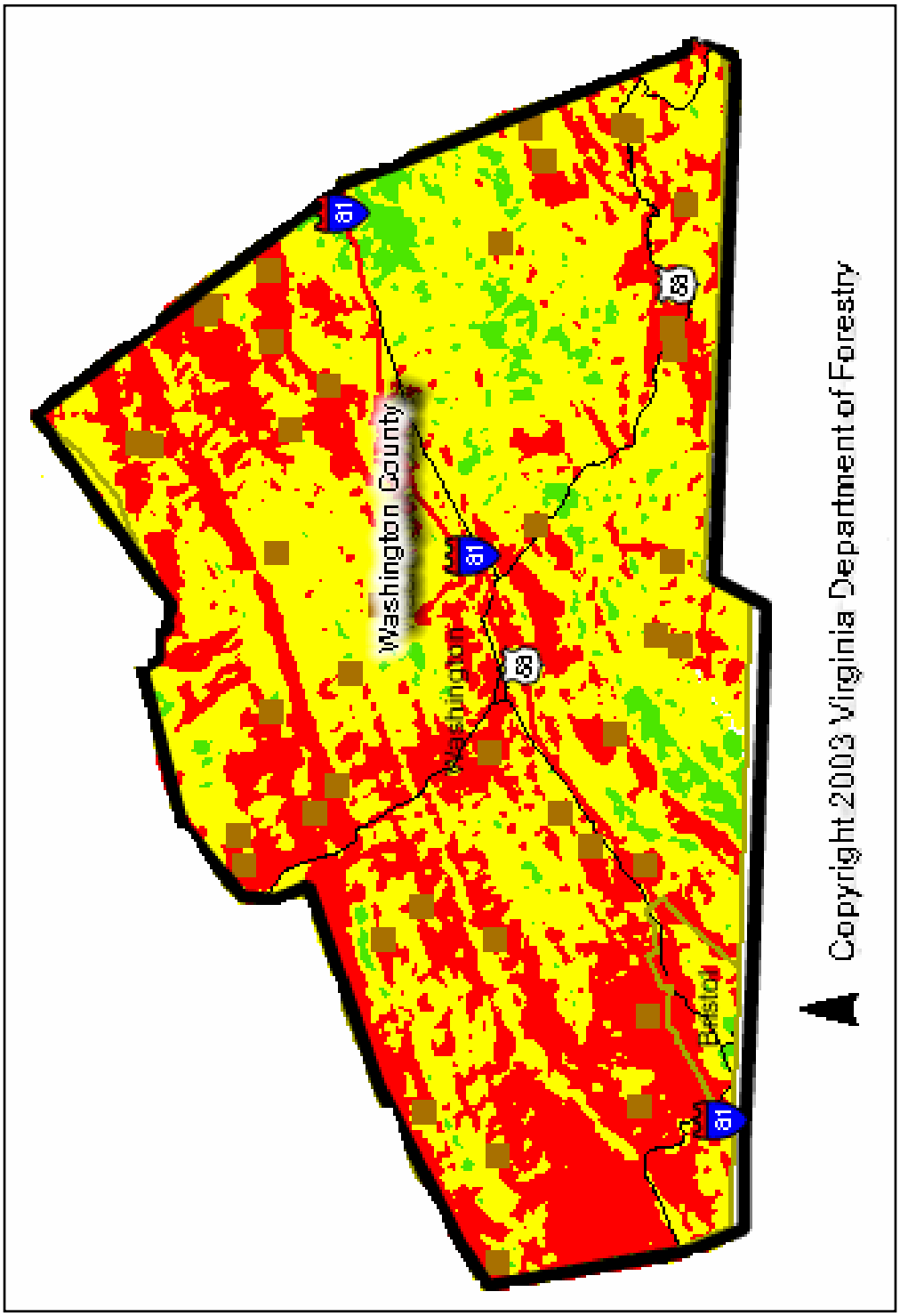
(See Map No. 21A, the regional map, for meanings of the different colors in the map)



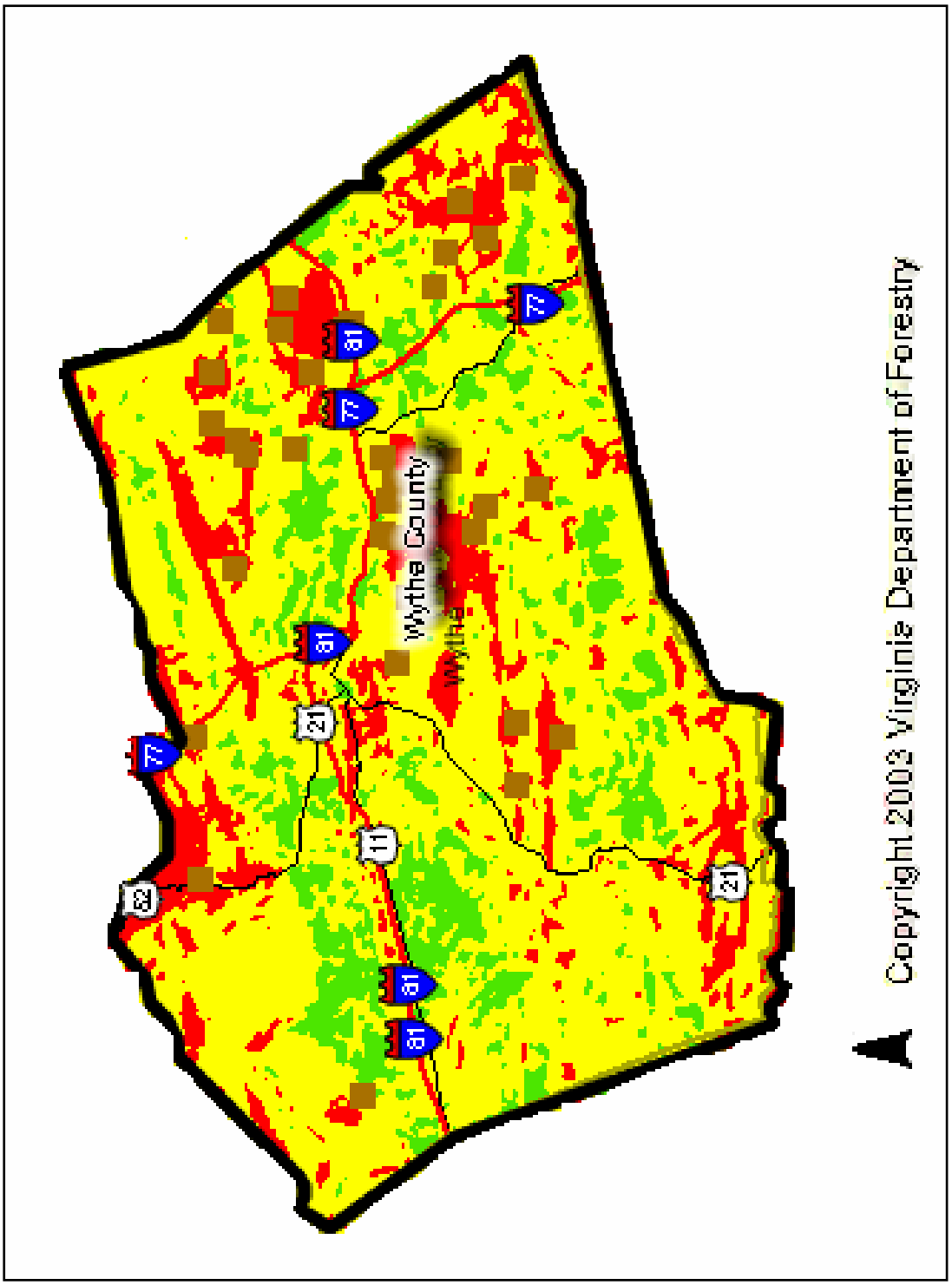
Map No. 25A
ForestRIM Image - Wildfire Risk in Smyth County
(See Map No. 21A, the regional map, for meanings of the different colors in the map)



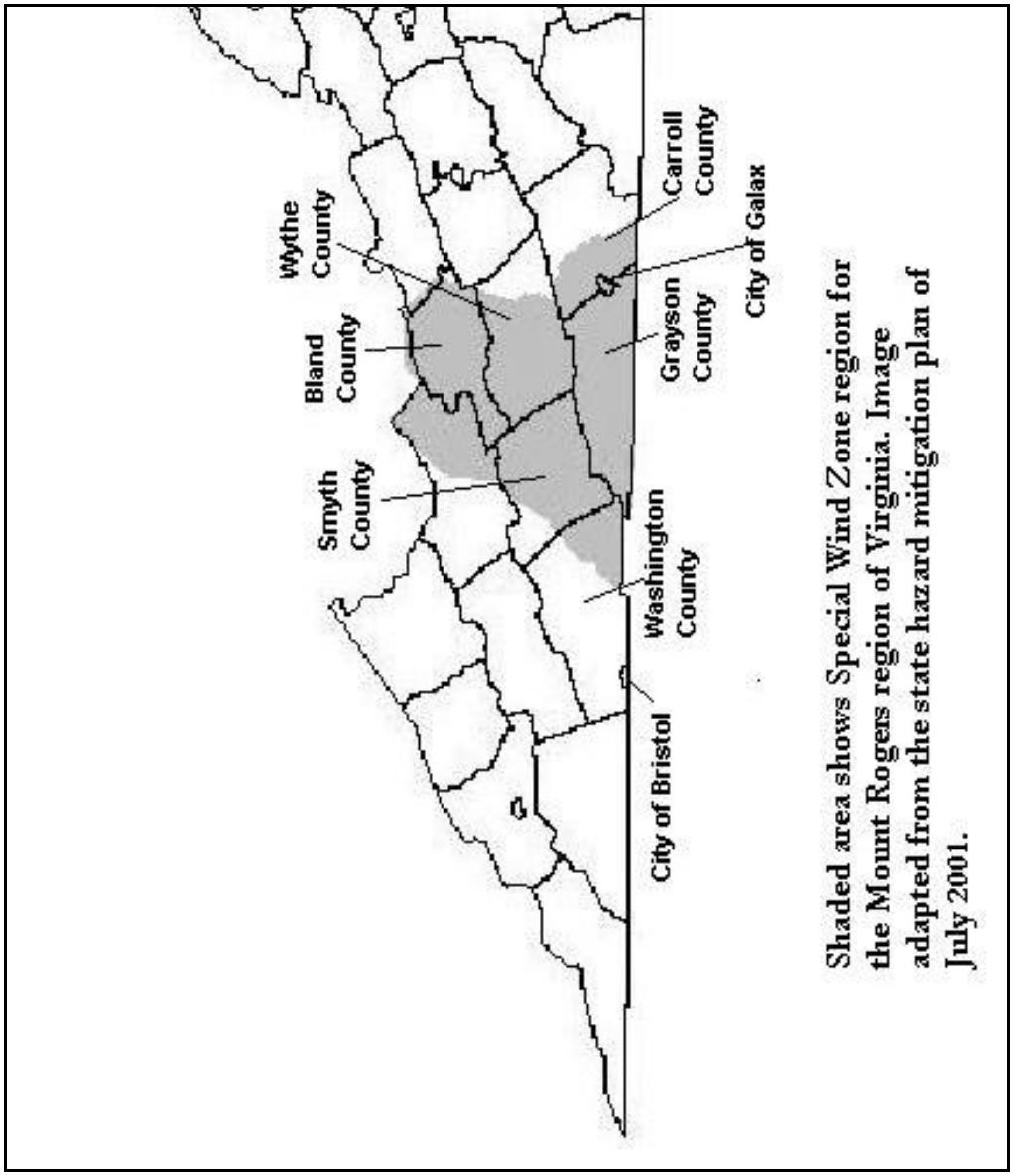
Map No. 26A
ForestRIM Image - Wildfire Risk in Washington County
(See Map No. 21A, the regional map, for meanings of the different colors in the map)



Map No. 27A
ForestRIM Image - Wildfire Risk in Wythe County
(See Map No. 21A, the regional map, for meanings of the different colors in the map)



Map No. 28A
Wind Region of Southwest Virginia
(Adapted by the MRPDC from the July 2001 Virginia Hazard Mitigation Plan)



Methods Used For Calculations

General Comments

For the most part we used our own methods to determine property damages in those instances where such determinations were possible. This applies particularly to potential damages from flooding and wildfires. See the following sections for more details. In many instances, due to lack of localized data – such as for karst and sinkholes, landslides, thunderstorms and lightning, severe winter storms and ice – we were not able to produce damage estimates.

We applied the HAZUS model only for estimates for potential earthquake damage. For the most part, HAZUS did not apply because it relies on localized models to feed into the HAZUS programming to produce results. These localized models do not exist for communities in the Mount Rogers region, so we largely dispensed with making calculations using HAZUS.

Some resources, such as weather and storm information from the National Climatic Data Center, is a good source for tracking storm history. The main drawback of the NCDC is that data is reported based on storm events, and these often occur over a wide region; the damage estimates generally cannot be localized enough to be of use in hazard mitigation.

Flood-Related Calculations

Depending on data available to us, we took varying approaches for flood damage calculations and for the potential costs of various mitigations.

For the Bristol, Virginia and Bristol, Tennessee communities, we relied on the work of the U.S. Army Corps of Engineers, which conducted a major flood mitigation study primarily on Beaver Creek, which flows through both Bristols and regularly causes major damage.

When available, we also used GIS-based data layers to derive estimates of property values (i.e., property containing structures, not simply vacant land) located within the floodplains recognized by FEMA. We did this even though we know many of the regulated floodplains are not accurately mapped because they have not been engineered to determine Base Flood Elevations. We followed the FEMA rule of using the best available data. We were able to use GIS-based data layers for Washington County (along with the towns of Damascus and Glade Spring) and for the towns of Chilhowie, Marion, and Saltville in Smyth County.

For large parts of the region where GIS-based data layers do not exist, we obtained tax-assessed values of a sample of developed properties located within the regulated floodplains. We used this method for properties in flood-prone parts of Smyth County, Wythe County, and Bland County. Flooding in developed areas is generally much less of a problem in Carroll and Grayson counties, although the independent City of Galax has experienced flooding problems twice within 11 months.

We also made cost estimates for flood mitigation based either on existing studies, such as the study for the two Bristols, or according to the principles behind FRED (Fix and Repair, Remove,

Elevate, or Demolish). In the instances where we made our own cost estimates, we applied the following criteria:

- If the first floor of a given property has been flooded twice (or more) within 50 years, that property would be a candidate for relocation out of the floodplain.
- If a given structure sustains some amount of flooding below the first floor twice (or more) within 50 years, that property would be a candidate for floodproofing (elevation).

For the mitigation cost estimates, we relied on the experience of a former employee of the Tennessee Valley Authority who now works as a flood mitigation consultant and most recently worked on mitigation projects in north Georgia and Tennessee. We used his estimates to obtain a ***generalized sense*** of what the various options under FRED might cost. We recognize these kinds of estimates are highly site-specific, dependent on local construction costs (which vary widely), and dependent on other factors, such as available funding and the wishes of individual property owners.

Based on the input of the flood mitigation consultant, we performed our analyses based on the following:

- We raised the tax-assessed values by 25% to derive an estimate of present market value.
- We estimated elevation costs at $41 per square foot.
- For relocations we used the estimated present market value and added 25% to cover estimated relocation costs (as would be required under the Uniform Relocation Act).
- For residential demolitions, we used a range of costs based on the square-footage of the structure ($4,000 for up to 1,000 s.f.; $4,500 for 1,000 s.f.-1,500 s.f.; $5,500 for 1,500 s.f.-2,500 s.f.; and $7,000 for 2,500 s.f.-$3,500 s.f.).
- For the most part we did not attempt to make estimates for anything larger, such as government buildings, churches, commercial structures or industrial buildings.

Time constraints prevented us from considering other approaches to flood mitigation, such as streambank stabilization, improvements to watershed functions, or other innovative approaches. In the case of the U.S. Army Corps of Engineers study for the two Bristols, we followed the recommendations as approved by the two cities.

Wildfires and Woodland Home Communities

Property loss estimates for the wildfire section of the Hazard Mitigation report are focused on potential losses of housing believed to exist in what is termed as the “wildland/urban interface.” These estimates do not cover the entire universe of potential losses from wildfire. Wildfires can destroy forests and forms of development other than housing. However, we chose to focus on woodland housing due to the direct threat to lives and property.

The loss estimates themselves are drawn from two sources: 1) Localized woodland housing data drawn from the Virginia Department of Forestry’s ForestRIM data system as available in the spring of 2004, and 2) Housing value estimates applied by the MRPDC, based on a January 2003 study by Virginia Tech called “Homeownership Affordability in Virginia.”

The information drawn from ForestRIM was preliminary in nature in 2004. This represents the best available data for the purposes of the Pre-Disaster Hazard Mitigation study.

The Virginia Tech study was a statewide report that estimated average housing prices by region. The New River Valley region included the counties of Bland, Carroll, Grayson, and Wythe and the City of Galax, with an average 2001 housing price of $129,926. The Southwest Virginia region included Smyth and Washington counties, with an average 2001 housing price of $119,780.

The prices cited in the study were driven by marketing information from the Virginia Association for Realtors,® based on housing sales tracked through the Multiple Listing Service (MLS). Generally, realtors in the Mount Rogers region are independent agents and do not participate in MLS. So, the housing prices cited by the study are driven by sales in communities other than those in the Mount Rogers region.

Woodland Home Communities: Development Trends

What is offered in the following narrative is an accounting of key trends described in community comprehensive plans and from population data by the Virginia Employment Commission and the University of Virginia. Because woodland home communities typically appear in rural settings, the comments here relate to the unincorporated areas of the six counties in the local region.

Bland County

Bland County is projected to have moderate growth in the next few years, going from 7,000 in 2003 to 7,600 in 2010, an increase of 8.6%. This is the smallest, least developed county in the Mount Rogers region.

Future growth most likely will occur along the I-77 corridor and near the highway exits at Rocky Gap, South Gap, Bastian and Bland. Extension of public water service also could spur residential and industrial development both west of Bland (along Rt. 21/52) and east of Bland (on Rt. 42). Many of these areas roughly correspond with regions of high wildfire risk identified through the ForestRIM database.

Projected population growth by 2010 may result in 261 new single-family units overall, with 32 units in woodland settings. That would bring the total woodland housing community to an estimated 293 housing units.

Carroll County

Carroll County could experience a 4.38% population increase by 2010, going from 29,700 in 2003 to 31,000, based on the most recent projections. Woodland housing, which comprises roughly 7% of all single-family housing in the county, could increase by 38 units to an estimated 750 units by 2010.

Housing growth could be spurred by development of a major regional water plant in Wythe County and infrastructure development in the I-77/Lambsburg area and the I-77/Rt. 620 area

near Twin County Airport. Other likely growth areas include the City of Galax, the U.S. Rt. 58 corridor between Hillsville and Galax, and the area northeast of Hillsville.

Woodland home development is a problem because many homes have been built on the upper face of the Blue Ridge Escarpment, where soils are thin and rocky and on-site septic systems may in time pollute drinking water sources. Some of these developments also are only accessible by steep, unpaved roads and cannot accommodate emergency vehicles.

Grayson County

The most current projections show limited growth for the county, going from 16,800 in 2003 to 17,100 in 2010, an increase of 1.8%. Single-family housing needs overall may increase by 130 units, with 10 in woodland settings. By 2010, total estimated woodland housing would amount to 268 units.

Grayson is attractive for woodland home development because of the scenic views and access to the New River. New development is bound to occur as a result of the Great Blue Ridge Mountain Auction of September 1999; the Dixon Lumber Company of Galax sold 13,000 acres of its holdings in Grayson, Carroll and Wythe counties. Other areas targeted for development include Point Lookout Mountain and Buck Mountain.

Future growth in and around the county seat of Independence also appears likely with plans evolving for a regional water plant in development by Grayson County and Independence in cooperation with Alleghany County and Sparta in North Carolina.

Smyth County

Located along I-81, Smyth County has maintained a base population of roughly 33,000 but has attracted only limited new housing. In the past this was blamed in part on lack of local land use control. The county has since enacted a zoning ordinance (effective January 2002); this may in the long run encourage some new housing development, including in woodland communities.

Population is projected to grow from 32,300 in 2003 to 33,800 in 2010, an increase of 1,500 people or 4.6%. This could translate into 652 new single-family housing units overall, with 29 in woodland settings. Total estimated woodland housing would then reach 504 total units by 2010.

Most of Smyth County’s growth should occur in the designated growth areas. One growth corridor follows the I-81 corridor, including the towns of Marion and Chilhowie. Another growth area is in the northwest corner (Saltville and surrounding area) and in much of the Rt. 107 corridor between Saltville and Chilhowie. Regions of high wildfire risk generally include the central portion of the county, its northwest corner, and scattered areas south of the I-81 corridor.

Washington County

Washington County has enjoyed steady population and housing growth for several decades. Conservative projections forecast a 1.35% growth rate between 2003 and 2010, bringing the population to 52,400. Projections shown in the 2002 update of the comprehensive plan would raise the population to 54,984, or a 6% growth rate between 2003 and 2010.

On the conservative side, need for new single-family housing by 2010 could amount to 304 units, with 15 in woodland settings. Alternatively, based on a 6% growth rate, overall single-family housing development might grow to 1,428 units, with 71 in woodland settings. So, the total estimated number of woodland homes in 2010 could range from 819 units to 875 units, depending on the projections used.

Given the county's strong growth trend, we applied the 6% rate as a better estimate of what appears likely to happen in the next few years. New growth most likely will occur broadly along the I-81 corridor, along Rt. 91 south to Damascus, and in the greater Bristol area. The greatest population concentrations will be in the established towns of Abingdon and Glade Spring.

Wythe County

ForestRIM data on woodland housing communities was not available for Wythe County when these calculations were made in the spring of 2004.

Table No. 18A: Population Estimates and Projections for 2000, 2003 and 2010

Locality	UVa Population Estimates			VEC Projections (May 2003)		
	Census 2000	**Provisional 2003**	**Avg. Annual Change**	**Projected 2010**	**% Change 2003-2010**	**Numerical Change 2003-2010**
Bland	6,871	7,000	0.40%	7,600	8.57%	600
Carroll	29,245	29,700	0.50%	31,000	4.38%	1300
Grayson	16,881	16,800	-0.20%	17,100	1.79%	300
Smyth	33,081	32,300	-0.80%	33,800	4.64%	1500
Washington*	51,103	51,700	0.30%	52,400	1.35%	700
Wythe	27,599	27,500	-0.10%	28,600	4.00%	1100

* Alternative estimates project a 6% growth rate to 2010, which would add 3,284 people instead of 700.

Table No. 19A
Woodland Housing Changes Based on Projected Population (for 2003 through 2010)

Locality	**Pop. Increase 2003-2010**	**Added SF Housing Needs**	**Woodland Housing % of SF Housing**	**Est. Change in Woodland Housing, 2003-2010**
Bland	600	261	12%	32
Carroll	1300	565	7%	38
Grayson	300	130	4%	10
Smyth	1500	652	6%	29
Washington*	700	304	5%	15
Wythe	1100	478	NA	NA

Added housing needs based on 2.3 persons per home.
Woodland housing needs based on percentage of single-family homes classified as woodland homes, as shown by 2000 Census data on single-family housing and ForestRIM data on woodland homes.
* Using the 6% population growth rate for Washington County, there could be need for 1,428 new single-family housing units, with roughly 71 in woodland settings. Total estimated woodland homes would then come to 875 units.

Future Land Use

The majority of land use in the Mount Rogers region is agricultural, or a combination of conservation and recreation. The highest concentration of low, medium, and high-density residential areas are near existing towns and communities. Concentrations of residential areas are also found in the localities' major transportation corridors, with more sporadic areas of residential development found in the region's outlying areas. For the most part, commercial and industrial land use is concentrated in the existing cities and towns.

Bland County future land use shows most of its land as agriculture or national forest. The residential areas are along the I-77 corridor, and in or near existing communities. Industrial areas are located along the I-77 corridor and in the eastern part of the county at the Bland Correctional Center.

Carroll County future land use has much the same trends as the rest of the Mount Rogers region. The county's future land use plan envisions development in and near the existing towns and communities, with new development along major roads.

Grayson County future land use has most of its lands either in agriculture or some kind of recreation either state or federal. There is very limited space designated toward industry within the county.

Smyth County future land use shows most of its land as agriculture or conservation/ recreation. The growth areas are mostly concentrated around the existing towns and communities. Commercial areas are located largely in the towns and in other areas along the I-81 corridor.

Washington County future land use shows the largest amount of land as open space. The majority of residential, commercial, and industrial land is found along the I-81 corridor, as well as in the towns of Damascus and Saltville.

Wythe County future land use shows most of its land is designated for agriculture. The rural residential growth areas are concentrated around the towns of Wytheville and Rural Retreat, as well as the I-81, I-77 corridor. Also, interstate commerce and industrial areas are found along the interstate highway system in the county.

The City of Bristol future land use envisions encouraging more retail development in the downtown area, as well as the need to support more high-tech industries that may move into the city. Also, they wish to develop land that may otherwise remain vacant.

The City of Galax future land use shows the majority of its low, medium and high density residential in the outlying areas of the city. In the centralized part of the city and along the major roads is where development trends have most of the commercial, industrial, and semi-public lands located.

Regional Hazard Mitigation Actions

Region: Bland County Action: Update FEMA Flood Plain Maps **Mitigation Action #**	
Category:	Update Information
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$7,000 per stream mile
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	MRPDC \ local governments \ VA Tech
Implementation Schedule:	FY 2006 Regional Application

Region: Bland County Action: Flood Mitigation Plan Rocky Gap **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$150,000
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	Bland County Board of Supervisors
Implementation Schedule:	FY 2007

Region: Carroll County Action: Update FEMA Flood Plain Maps **Mitigation Action #**	
Category:	Update Information
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$7,000 per stream mile
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	MRPDC \ local governments \ VA Tech
Implementation Schedule:	FY 2006 Regional Application

Region: Carroll County Action: Conduct Fire Safety Workshops **Mitigation Action #**	
Category:	Public outreach and education
Hazard(s) Addressed:	Fire \ Drought
Priority (High, Moderate, Low)	High
Estimated Cost:	$100,000
Potential Funding Source(s):	USDA; VA Dept. of Forestry
Lead Agency/Department Responsible:	Firewise \ local governments \ MRPDC \ RC&D
Implementation Schedule:	Ongoing

Region: Carroll County Action: Design an Early Warning System for Hazard Events **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Snowstorms/Ice/High Winds/ Traffic Flow/Wrecks
Priority (High, Moderate, Low)	Low
Estimated Cost:	$100,000-$500,000
Potential Funding Source(s):	FHWA
Lead Agency/Department Responsible:	VDOT
Implementation Schedule:	2010

Region: Grayson County Action: Update FEMA Flood Plain Maps **Mitigation Action #**	
Category:	Update Information
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$7,000 per stream mile
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	MRPDC \ local governments \ VA Tech
Implementation Schedule:	FY 2006 Regional Application

Region: Grayson County Action: Conduct Fire Safety Workshops **Mitigation Action #**	
Category:	Public outreach and education
Hazard(s) Addressed:	Fire \ Drought
Priority (High, Moderate, Low)	High
Estimated Cost:	$100,000
Potential Funding Source(s):	USDA; VA Dept. of Forestry
Lead Agency/Department Responsible:	Firewise \ local governments \ MRPDC \ RC&D
Implementation Schedule:	Ongoing

Region: Smyth County Action: Update FEMA Flood Plain Maps **Mitigation Action #**	
Category:	Update Information
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$7,000 per stream mile
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	MRPDC \ local governments \ VA Tech
Implementation Schedule:	FY 2006 Regional Application

Region: Town of Marion Action: Flood Mitigation Plan **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$250,000 - $300,000
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	Town of Marion
Implementation Schedule:	FY 2007-2008

Region: Town of Chilhowie Action: Flood Mitigation Plan **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	Moderate
Estimated Cost:	$100,000
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	Town of Chilhowie
Implementation Schedule:	FY 2007-2008

Region: Washington County Action: Update FEMA Flood Plain Maps **Mitigation Action #**	
Category:	Update Information
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$7,000 per stream mile
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	MRPDC \ local governments \ VA Tech
Implementation Schedule:	FY 2006 Regional Application

Region: Glade Spring Action: Flood Mitigation Plan **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	Moderate
Estimated Cost:	$100,000
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	Town of Glade Spring
Implementation Schedule:	FY 2007-2008

Region: Wythe County Action: Update FEMA Flood Plain Maps **Mitigation Action #**	
Category:	Update Information
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$7,000 per stream mile
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	MRPDC \ local governments \ VA Tech
Implementation Schedule:	FY 2006 Regional Application

Region: Wythe County Action: Design an Early Warning System for Hazard Events **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Snowstorms/Ice/High Winds/ Traffic Flow/Wrecks
Priority (High, Moderate, Low)	Low
Estimated Cost:	$100,000-$500,000
Potential Funding Source(s):	FHWA
Lead Agency/Department Responsible:	VDOT
Implementation Schedule:	2010

Region: Town of Wytheville Action: Flood Plain Mitigation **Mitigation Action #**	
Category:	Emergency Services Public Outreach
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	Moderate
Estimated Cost:	$150,000
Potential Funding Source(s):	FEMA; Corp. of Engineers; DHCD; ARC
Lead Agency/Department Responsible:	Town of Wytheville
Implementation Schedule:	FY 2007

Region: Town of Rural Retreat Action: Design Storm Drainage System **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	Low
Estimated Cost:	$100,000
Potential Funding Source(s):	FEMA; DHCD; ARC; VDOT
Lead Agency/Department Responsible:	Town of Rural Retreat
Implementation Schedule:	FY 2007

Region: City of Bristol Action: Implement Corp. of Engineers Study **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	High
Estimated Cost:	$3,000,000 +
Potential Funding Source(s):	REMA; VDEM; Corp. of Engineers
Lead Agency/Department Responsible:	City of Bristol VA
Implementation Schedule:	FY 2006

Region: City of Galax Action: Implement Storm Drainage Plan **Mitigation Action #**	
Category:	Emergency Services
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low)	Moderate
Estimated Cost:	
Potential Funding Source(s):	FEMA; CDBG; VDEM; ARC
Lead Agency/Department Responsible:	City of Galax
Implementation Schedule:	FY 2007

FUNDING RESOURCES

Department of Energy Community Services Team

Function: The **Sustainable Development Assistance Program** works with communities to help define and implement sustainable development strategies as part of comprehensive community planning. Offers technical assistance to communities affected by disasters through introduction of environmental technologies and sustainable redevelopment planning practices.

More information: See http://www.sustainable.doe.gov.

Department of Homeland Security

Function: Provides funding for broad-based local capacity building for emergency services groups such as police, fire/rescue, public health, and local departments of emergency services. Focus on purchase of supplies.

More information: For resources on training, see the Emergency Management Institute (http://training.fema.gov/EMIWEB). Also see www.dhs.gov/dhspublic.

Department of Housing and Urban Development (HUD)

Function: Provides supplemental aid under the **Disaster Recovery Assistance** program, which is funded through the Community Development Block Grant program. This offers added money for recovery from major federal disasters. Grants available to states and general local governments.

Community Development Block Grant: Grant program to create viable urban communities by providing decent housing to benefit low- to moderate-income people. These funds are available on a competitive basis. The program includes acquisition, rehabilitation, and reconstruction of properties/facilities damaged by a disaster.

More information: http://www.hud.gov/offices/cpd/communitydevelopment/programs.

Department of Transportation (part of the Federal Highway Administration)

Function: The Transportation Emergency Relief Program helps repair federal-aid roads by using new technologies to improve the qualify and lifespan of the roadways.

More information: See http://www.fhwa.dot.gov/progadmin/erelief.html.

Economic Development Administration (part of U.S. Department of Commerce)

Function: Grant support to states and localities implement strategies to adjust from sudden and severe economic dislocation. This can include projects tore build public facilities damaged by natural disasters.

More information: See http://www.doc.gov/eda (look for the Economic Development and Adjustment Program, Sudden and Severe Economic Dislocation).

Farm Service Agency (part of U.S. Department of Agriculture)

Function: Federal funding aid to help disaster-related losses by farmers, repair and rehabilitation of farmlands harmed by natural disasters, provide emergency loan assistance, emergency aid for haying and grazing areas, and provide emergency assistance for uninsured crop disasters. Specific programs include **The Agricultural Assistance Act of 2003**, the **2003 Non-fat Dry Milk Livestock Feed Assistance**, **Emergency Conservation Program** (for repair of farms damaged by natural disaster, such as drought), **Emergency Loan Assistance** (to help farmers recover from production and physical losses due to natural disasters), **Emergency Haying and Grazing Assistance** (as applies to certain Conservation Reserve Program lands), and the **Noninsured Crop Disaster Assistance Program**.

More information: See http://disaster.fsa.usda.gov.

Federal Emergency Management Agency (FEMA, found at www.fema.gov)

Function: Grants and loans to state and local governments and private non-profit organizations. Funds are for areas that have been declared as federal disaster areas. Includes the **Public Assistance Program** (federal share at least 75%, local match shared between state and locality), **Community Disaster Loans** (disaster aid to local governments that have sustained substantial loss of tax revenue due to disasters), and the Emergency Management Institute, the national FEMA emergency training center at Emmitsburg, Maryland.

Disaster Housing Program: Provides aid for short-term lodging, home repair, rental aid, and mortgage and rental aid. Available through the FEMA Response and Recovery Directorate (see http://www.fema.gov/rrr).

Flood Mitigation Assistance Program: Provides grants to state and local governments for planning aid and projects to reduce the risk of future flood damages. This includes elevating homes, conversion of developed land to open space, and drainage improvements for structures covered by NFIP insurance.

Hazard Mitigation Grant Program: To reduce the cycle of repetitive disaster damage by providing grants to state and local governments (up to 74% federal share, remainder from non-federal sources). Provides funds for cost-effective, sustainable, long-term mitigation measures.

Historic Properties and Preservation: Provides federal aid for repair, restoration and mitigation of historic structures damaged by disaster, through the **Repair and Restoration of Disaster-Damaged Historic Properties** program).

National Dam Safety Program: Provides grant aid to states to improve their dam safety programs. It offers funds for research and training. This program also supports the National Inventory of Dams compiled by the U.S. Army Corps of Engineers.

National Flood Insurance Program: Provides taxpayer-subsidized flood insurance to property owners in communities with identified flood hazard areas. Participating communities must enforce floodplain regulations. In return, the flood insurance is made available at a reduced cost to property owners. Communities that wish to exceed the minimum NFIP standards can do so through the Community Rating System.

More information: See www.fema.gov and http://training.fema.gov/EMIWEB. On community disaster loans, see www.cfda.gov/public. Also, see FEMA's online library at http://www.fema.gov/library.

Food and Nutrition Service (part of U.S. Department of Agriculture)

Function: Supply food to disaster relief organizations, such as the American Red Cross and the Salvation Army for mass feeding or household distribution. The program is called **Food Disaster Assistance.**

More information: See http://www.fns.usda.gov/fdd/programs.

National Park Service (part of the U.S. Department of the Interior)

Function: To acquire and develop outdoor recreation areas and facilities (through **Land and Water Conservation Fund** grants), and to repair recreation areas and facilities, demonstrate innovative management methods, and develop improved recreation planning. The **Park and Recreation Recovery Program** helps localities provide recreational facilities in disaster-prone areas.

More information: See http://www.nps.gov/uprr and http://www.doi.gov/news.states.

Natural Resource Conservation Service (part of U.S. Department of Agriculture)

Function: Protect life and property through emergency measures to prevent soil runoff and erosion and to protect floodplains from damage by floods, drought and the products of erosion. This is called the **Emergency Watershed Program** and is available regardless of whether a federal disaster has been declared. Another resource is the **Defending Against Drought Program** (to reduce drought impacts to farms and ranches).

Other programs include the **River Basin Program** (planning aid to federal, state, and local agencies for coordinated water and land resource programs) and the **Watershed Protection**

and Flood Prevention program (offering technical and financial aid to implement improvements and protection of land and water resources in small watersheds.

More information: See htttp://www.nrcs.usda.gov/programs.

Rural Development (part of U.S. Department of Agriculture)

Function: Grant and loan aid to rural communities and residents of rural areas affected by natural disasters and to promote economic development of rural communities with exceptional needs. Programs include **Emergency Community Water Assistance Grants** (for communities with populations of 10,000 or less and that are suffering from a significant decline in drinking water quality or quantity; grants may cover 100% of project costs), **Rural Business Opportunity Grants** (promote sustainable economic development for rural communities, provide technical help for rural businesses and train rural entrepreneurs), **Housing and Community Programs Assistance** (loans to individual victims of disaster, as a supplement to SBA disaster loans).

More information: See http://rurdev.usda.gov.

Small Business Administration (SBA, found at www.sba.gov)

Function: Loans to businesses and homeowners in federal disaster areas. Programs include **Physical Disaster Business Loans** (available to any business located in a declared disaster area), **Economic Injury Disaster Loans** (for small businesses and small agricultural cooperatives), **Personal Property Loans** (for renters or homeowners in a declared disaster area, for amounts up to $40,000), **Real Property Loans** (available only to homeowners for up to $200,000), **Pre-Disaster Mitigation Loans for Small Business** (pilot program available to small businesses and supported by FEMA), **Military Reservist Economic Injury Disaster Loan Program** (funds to small businesses unable to meet their obligations due to the military "call up" of an essential employee).

More information: See SBA website at www.sba.gov.

U.S. Army Corps of Engineers (part of U.S. Department of Defense)

Function: The Flood Control Works/Emergency Rehabilitation program helps repair and restore public works damaged by floods, winds, waves, or water action. Provides public works and engineering support as a supplement to state and local effort to recover from natural disasters.

More information: See http://www.spd.usace.army.mil/hqpam.html.

U.S. Forest Service (part of U.S. Department of Agriculture)

Function: Fire protection on national forest lands, fire weather observations and forecasts, aid to state and federal agencies to suppress wildfires, and emergency measures on state and private lands suddenly damaged by fire, flood, and other natural disasters. The Forest Service role includes communication networks, disaster coordination management teams, air transportation, firefighter crews, and help with the organization of multi-agency response.

Also works in cooperation with the Natural Resources Conservation Service and its Emergency Watershed Program for planning and installation of emergency conservation measures to prevent more disaster damage to communities, public water supplies, and transportation systems.

More information: http://fs.fed.us.

OTHER NOTES ON SPECIFIC HAZARDS

Disaster Preparedness

Property owners can do much in the way of preparation to mitigate against the immediate impacts of natural hazards. Organizations such as the Federal Emergency Management Agency (FEMA), the American Red Cross, and the National Association of Resource Conservation & Development Councils have all developed standing advice on specific steps people can take to survive disasters in the first few days before help might be expected to arrive.

As a general rule, people are advised to stock at least three days' worth of emergency supplies, because that's how long it takes, on average, before emergency responders can be on site and organized to begin helping disaster victims.

For those who live in remote rural areas – and this applies to many parts of the mountainous Mount Rogers region of Virginia – it might be advisable to plan for even longer time spans before outside help becomes available. The standard three days' worth of supplies might be extended to at least seven days.

Other general advice includes the following:

1) Learn about the potential natural disasters that can occur in your community.
2) Make plans for the household – including teaching children how and when to call 911; how to remain in contact if family members become separated; how to shut off water, gas, and electricity at the main switches; take first aid and CPR training; keep household insurance policies up-to-date with sufficient coverage; make arrangements for pets, which normally are not allowed in public shelters (other than service animals, such as seeing-eye dogs).
3) Prepare a disaster supply kit to include food, water, and other basic supplies.
    - Allow up to one gallon of drinking water per day per person.
    - Use clean, intact plastic bottles to store water (don't use breakable containers, such as glass or containers that held toxic substances).
    - Change stored water and food every six months.
    - Store a supply of canned foods, dry mixes, and other staples.
    - Provide a manually operated can opener.
    - Have first aid supplies available (bandages, cleaning agents, scissors, etc.)
    - Have basic medications available (aspirin, anti-diarrhea drugs, antacid, vitamins, etc.)
4) Emergency supplies include tools such as battery-powered radios, flashlights and extra batteries, signal flares, matches, duct tape and scissors, plastic sheeting, whistle, tube tent, work gloves, needles and thread, etc.
5) Other supplies to have on hand include:
    - Kitchen items (manual can openers, camping supplies, all-purpose knives, household liquid bleach to treat drinking water, spices, re-sealing plastic food bags)
    - Sanitation and hygiene supplies (towels, soap, toilet paper, garbage bags)

- Household documents and emergency contact information stored in a secure, watertight container.
- Clothes and bedding (one complete change of clothes and shoes for each household member, rainwear, thermal underwear, sturdy work shoes, sunglasses, blankets or sleeping bags).
- Specialty items (to meet needs of babies, elderly people, disabled people, pets, and entertainment, such as books, toys, games, stuffed animals).

6) Be ready to evacuate the premises when advised to do so by emergency responders.
7) Much more information is available from these sources:
    - American Red Cross at www.redcross.org/services/disaster.
    - Your local American Red Cross office.
    - Federal Emergency Management Agency at www.fema.gov.
    - Fact sheets from the National Association of RC&D Councils at www.rdcnet.org.

Firewise Techniques

Much information is already available through the Virginia Department of Forestry and work being done by the New River-Highlands RC&D Council. Principles developed through the Firewise program mainly relate to using fire-resistant materials when building in wooded settings and cutting back and/or eliminating vegetation within close reach of the house or other buildings on the property.

An outline called the "Firewise Landscaping Checklist" advises creating a firewise landscape by removing vegetation and other fuels that could start fires. This is done by landscaping to create four zones around the property as follows:

- Zone 1: Defined by the first 30 feet surrounding the property. Fuels and vegetation are removed to provide access by emergency vehicles. Plantings should be limited to species that resist fire.

- Zone 2: This stands further away and should mainly consist of low-growing fire-resistant plants. Wildfires burn upwards to tree crowns and then pass from crown to crown, making the problem worse.

- Zone 3: This stands still further away. Zone 3 should contain only low-growing plants and well-spaced trees in this area.

- Zone 4: This zone stands the furthest from the woodland home or other structure and is treated as a natural area. Here the landowner should selectively prune and thin all plants and remove highly flammable vegetation.

Firewise techniques require implementation and continuing maintenance, since vegetation grows back year after year. It is also important to have a good irrigation system to support the property and also to serve as a water supply to suppress fires. Structural methods, such as installing barriers to keep fallen leaves from collecting under the deck, also come into play with the Firewise program.

The cost of implementing Firewise projects vary highly among individual properties, depending on the condition of the building site, the density of flammable vegetation, the lay of the land, and other factors. Demonstration projects carried out by the New River-Highlands RC&D Council have created costs ranging from $1,500 (Koji property along Blue Ridge Parkway south of Galax) to $8,000 (Echo Hills Woodland Community in Montgomery County).

For more information, see the following:

- Firewise program at www.firewise.org.
- National Fire Plan at www.fireplan.gov.
- National Wildland/Urban Interface Fire Protection Program at www.firewise.org/library.

Low-Impact Development

Low-impact development (LID) is not treated in any depth in this Pre-Disaster Hazard Mitigation Plan. LID can be a useful technique to reduce natural hazard risks, but it depends on the willingness of localities to enforce land use regulations, which remain controversial in some parts of the Mount Rogers Planning District region.

Some members of the Hazard Mitigation Advisory Team mentioned LID as a potential mitigation for flooding risks, to reduce development stress, especially on the flood fringe parts of the local floodplains. So some reference to LID is being made here to serve as a starting point for future investigation, consideration, and possible implementation by the localities.

Basic LID principles include the following:

- Control stormwater pollution.
- Protect watersheds, especially those under development pressure.
- Promote environmental sustainability.
- Restore natural hydrological functions (improve permeability of the urbanized landscape).

Traditional engineering approaches focus on providing drainage structures to speed the flow of stormwater unable to sink into the ground due to impermeable development (roads, buildings, parking lots, solid sidewalks, etc.). LID principles reverse that idea to aim to improve the natural permeability of the landscape, reduce overland flooding, mimic the dispersed drainage functions of a natural, virgin landscape, and in general to add “green” to urbanized areas, including such unusual ideas of creating “green” (vegetated) roofs to help absorb rainwater.

LID has been applied in Prince Georges County, Maryland and in Stafford County, Virginia, as well as other locations around the country. The New River-Highlands RC&D Council sponsored the Tri-State Regional Low Impact Development Conference in May 2004 in Wytheville. LID is a new concept that will take time for people to understand and possibly implement in the local region.

Seven benefits offered by LID are described in a publication by the Natural Resources Defense Council[127] as follows:

- **Effective**: Simple, practical, and universally applicable to the urbanized landscape.
- **Economical**: Often less costly than traditional stormwater controls and drainage systems.
- **Flexible**: LID is applied on a small scale and can be tailored to specific sites.
- **Adds Value to the Landscape**: Makes efficient use of land for stormwater management and therefore creates less interference than conventional methods.
- **Achieve Multiple Objectives**: Can be overlapped with other systems, such as combined sewer overflow, and results in benefits such as substantial reductions in the speed and volume of flooding.
- **Follows a Systems Approach**: Integrates numerous strategies.
- **Makes Sense**: Helps developers and local governments re-think how they approach new environmental regulations designed to protect water quality and reduce impacts from flooding and stormwater flows.

For more information, see the following:

- Natural Resources Defense Council at www.nrdc.org/water/pollution/storm/chap12.asp.
- Environmental Protection Agency at www.epa.gov/owow/nps/lid.
- LID Clearinghouse at www.lid-stormwater.net/clearninghouse.

Winds

High winds are a special concern for the Carroll-Grayson-Galax part of the Mount Rogers region and have been a point of discussion by the Hazard Mitigation Advisory Team. This has been described already in the Hazard Assessment and Vulnerability section of this Plan, as well as in the mitigation recommendations for the localities.

Mitigating against the damaging impacts of winds mainly involves thorough enforcement of building codes and reinforcing existing structures. But even that will not solve the whole problem until more is done to improve the structural integrity of mobile homes[128], which typically are manufactured in parts of the country where potential impacts of winds are not taken into account. The long-term solution to this problem would require new legislation approved

[127] From "Stormwater Strategies: Community Responses to Runoff Pollution," Chapter 12, Low Impact Development. Found at www.nrdc.org/water/pollution/storm/chap12.asp.
[128] Personal communication, Virginia Department of Emergency Management.

through the Virginia General Assembly that would create stricter regulations for mobile homes sold in this state.

Investigations following the record-setting damages of Hurricane Andrew have shown that structures should be checked for weaknesses, especially in areas prone to hurricanes and similar high-wind events. The most likely places to find structural weaknesses include the roof, windows, doors, and garage doors.

Steps can be taken to reinforce the weak areas, either on a temporary basis (such as applying plywood over windows in advance of an oncoming storm) or as a permanent retrofit (installing storm shutters, reinforcing roof bracing, applying hurricane straps, special reinforcing door bolts, and retrofits for garage doors, especially if they are of double-wide construction.

For more information see:

- "Against the Wind: Protecting Your Home from Hurricane Wind Damage," a joint publication of the American Red Cross, FEMA, The Home Depot, the National Association of Home Builders, and the Georgia Emergency Management Agency.
- FEMA: *Taking Shelter From the Storm: Building a Safe Room Inside Your House,* FEMA Publication 320, 1st edition, October 1998.

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